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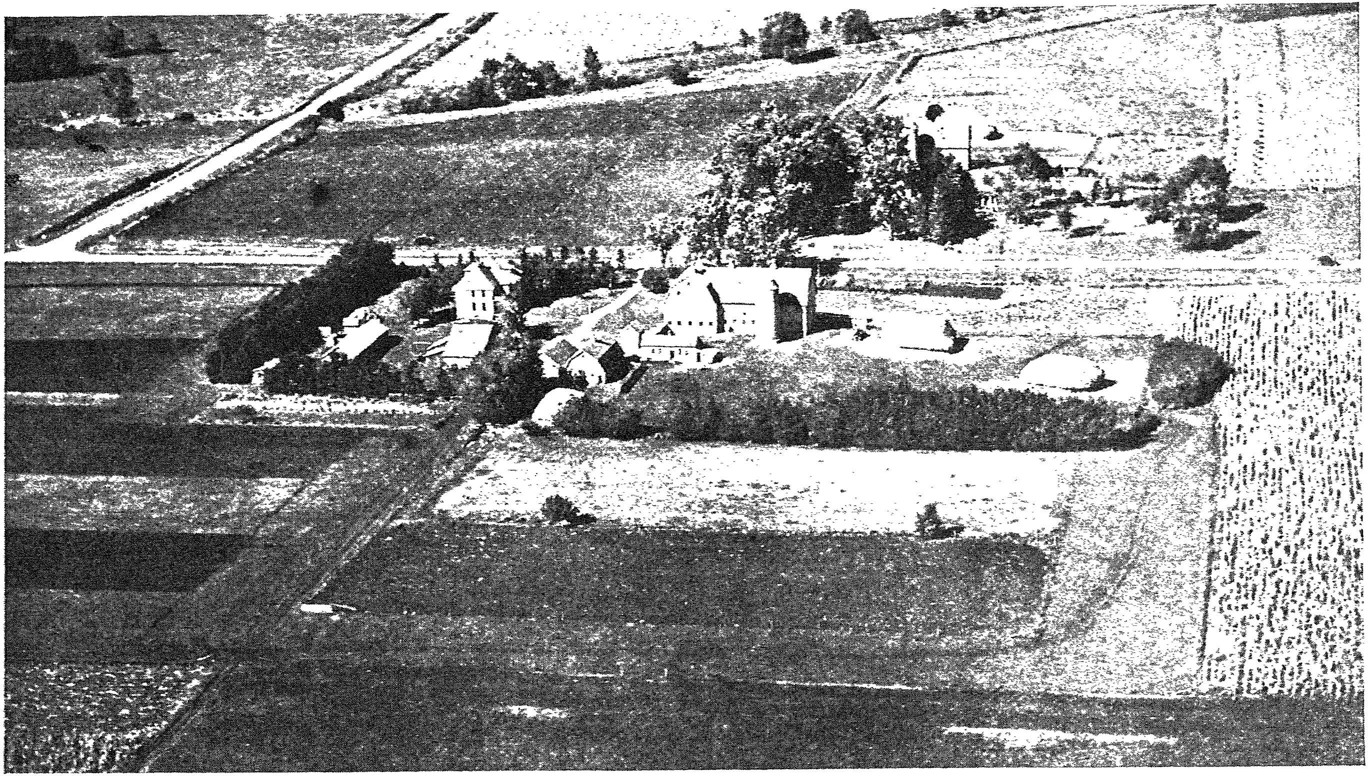
AMERICAN FARMING

AGRICULTURE III



Out of efficient operation arise good farm buildings, ample equipment, and productive fields.

AMERICAN FARMING

AGRICULTURE III

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PREFACE

Agriculture I and *Agriculture II* in this series of our four books on American Farming deal, firstly, with the resources that serve as the foundation of rural life and the agricultural industry, and, secondly, with the nature and inter-relationships of these primary resources with each other in the organization of an efficient farm business. The text material presented and methods of instruction suggested in the two books are designed to provide students with an appreciative understanding of the basic elements underlying the agricultural industry and the factors that influence the activities and color the experiences of those who farm.

Having gained knowledge of these interactive elements that comprise the farm business and some understanding of the ways in which each is to be fitted into the whole pattern of "balanced farming"—organization, students are now ready to enter upon a study of the next phase of learning how to farm — operation.

Agriculture III treats of *farm operation.* This book has been prepared from the strictly vocational point-of-view. Since functional learning is best achieved in realistic, life-like situations, much of the material in this book, as in *Agriculture II*, has been developed from the actual records, practices, decisions, and experiences of farmers in their normal farming operations. Studies of the records from a southern Minnesota dairy farm, used in demonstrating plans for organizing farms in *Agriculture II*, have been continued and used in *Agriculture III* to illustrate methods to be employed in showing the results attained from operating a farm. The records also serve as a basis for analysis of the efficiency with which a farm is operated. These records are used merely to demonstrate methods that may be employed in studying the operation of farms and improving the results from farming operations.

The authors have combined the results of research work at the various state experiment stations and the United States Department of Agriculture with the practices and experiences of successful farmers. The subject matter relating to the production and management of crops and livestock is presented with a view to giving students a clear understanding of the interrelated processes and practices that are followed by farmers in their actual operation of farms.

The instructions offered in the text will be more effective if accompanied by supplementary assignments of work in the form of systematically organized projects that will give personal experience in the production of crops and livestock.

Resourceful teachers and interested students will go beyond the mere study and mastery of the materials presented here or in other selected sources. If procedures are based on the principle that learning and behavior are integrated, then students, teachers, and parents will join in planning and carrying out appropriate learning experiences which are intimately related to realistic home farm situations and adapted to individual student interests, abilities, needs, and opportunities for practice. The authors believe that, step by step through experiencing, the student will be inducted into the realities and responsibilities of operating the home farm.

Suggestions were made in *Agriculture II* (page 15) that each student map and inventory his home farm or some other farm available to him. It was also suggested that each student should enter in an appropriate account record book all business transactions and significant data on crop and livestock production (page 17). These records, if kept, will be invaluable during the study of farm operation, serving to identify those phases of home farm operation that are of greatest importance. Injecting the family farm into the study program of the student will serve as a motivating influence because of the partnership implications in the study pattern. Students' awareness of mistakes in operation will enable the home farm operator to remedy defects and to improve the earnings of the business. Student experience in such problems serves to lead the individual progressively from his smaller projects to broader experiences and responsibilities, arouses interest in inter-related farm enterprises, develops self-confidence, and stimulates the student's desire to extend his supervision to a whole farm business unit. The student's farm practice program at this stage should include the experiencing of many and varied approved practices in the operation of the farm as a whole.

The success attending the use of this book will depend upon the energy, resourcefulness, and enthusiasm of the instructor in agriculture. To make subject materials vital and realistic, it must be intimately associated with the lives of the students. Not all will be equally interested in the problems of the farm. Students differ in maturity, mental ability, experience, and in the desire for knowledge. Farms differ in quality, earnings, and appeal. There are individual differences in farms as well as in students. Upon the instructor must fall the responsibility for adapting the presentation of the subject matter to the interests, needs, abilities, and opportunities of the individual students. It is an arduous but inspiring task for those who desire to raise the level upon which farming is done.

It is generally accepted that appropriate Farm Mechanics activities should be provided as an integral part of the learning-to-farm program. Opportunities for study and practice of the problems of purchase, initial cost and maintenance, care and repair and the proper operation of farm machinery and equipment are important phases of modern farming activities. The limitation of space in this book does not permit adequate treatment of the many important problems of mechanics as they relate to the efficient operation of a farm. Teachers are urged to make use of the many excellent available materials in Mechanics and Farm Management according to the needs of individual students.

Again the authors are indebted to numerous but unnamed authors, writers, and research workers. They are under obligations also to their colleagues in the University of Minnesota and other educational institutions. Dr. S. A. Engene, Division of Agricultural Economics, provided the data and organized the discussion in Chapters II, III, IV and V for which grateful acknowledgement is made. Thanks are due Dr. H. K. Hayes, Chief, Division of Agronomy and Plant Genetics, for his careful and constructive criticisms on the section dealing with plants.

The United States Department of Agriculture, the Photographic Laboratory at University Farm, the Farm Credit Administration, St. Paul, and numerous commercial institutions have provided many of the illustrations used. Grateful acknowledgement is made to all these offices and agencies. A list of the sources of illustrations used appears on page 477.

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AMERICAN FARMING

AGRICULTURE III

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CHAPTER I

FARM OPERATION COMPARED WITH FARM ORGANIZATION

In Chapters I to VI inclusive, *Agriculture II*, a study was made of the principles involved in the organization of a farm business unit. It is our purpose in *Agriculture III* to give careful consideration to the principles and practices involved in successfully operating a farm unit after the preliminary organization plans have been completed. That a clear understanding may be reached of the duties and functions of the farmer in his capacity as both *organizer* and *operator* attention will first be given to comparing the functions of organization with the functions of operation and management.

THE FUNCTIONS OF ORGANIZATION

As the organizer of a farm business, the farmer is concerned chiefly with making plans and in providing correct proportions between the different parts of the unit he is organizing. First of all, he must have or acquire sufficient funds or capital goods to provide the land, buildings, equipment, and labor necessary. He decides where he will farm, the type of farm he will operate, and the equipment he will need. He must decide how much land it will be wise to include in the farm and the kind and number of buildings that will be needed. The equipment and livestock, if any is to be kept, must be selected, and the proportions of each determined. Plans must be made for the division of the farm into fields of suitable number and size, the crops that will be raised, and the rotations to be practiced, if any. In making these plans one must keep in mind the uses to be made of each crop or product and the form in which it will be used or marketed.

It will not be possible to make plans that can be followed without revision from time to time as experience and changing conditions show the need for reorganization. The more complete and well considered the organization plans are, however, the less will be the need for expensive changes in organization. It is wise to draw several alternative plans of organization for a farm before adopting one as final. Estimates of possible production and income and of probable labor requirements and expense in operating will be most helpful in reaching a right decision in many cases.

To organize means to put together in an orderly way all the parts of the whole, to establish harmony between the parts, to plan for systematic production, or output—to bring into balance all the parts of the whole unit. Applied to a farm unit, organization means to bring into correct balance the elements of capital, land, labor, and management involved in the enterprise.

THE ELEMENTS OF FARM OPERATION

A machine in the finished form is the result of careful planning, assembly, and organization. It is useless, however, until put into action or operation. The operator puts life into the machine by throwing a switch, opening a valve, or by applying some other kind of power. After starting the machine, the operator must control the speed, the direction, and the load to be carried or the work to be done. If it gets out of control, damage to the machine or other property may result.

A farm, like a machine, should be the result of thoughtful planning, carefully built into a systematic well-organized unit ready to operate. Like the machine, a farm is put into action by the operator. Instead of throwing a switch or opening a valve, however, the operator starts the farm into action by preparing the land, sowing the seed, feeding and caring for animals, and giving attention to the many ever-recurring, overlapping tasks that crowd into each succeeding day. When once set in operation, the operator must continually direct the activities of the workers, and make decisions as to the work that shall first be done and the methods to be employed. On the skill of the operator depends the success of the enterprise and the personal or financial reward. Unless operations are wisely guided and controlled, damage to land, equipment, livestock, or the financial investment will result.

RESPONSIBILITIES OF THE FARM OPERATOR

The responsibilities of the farm operator are many and varied. It is his duty to handle the land to the best possible advantage, not only that large crops may be raised at the present, but that its productive power may be preserved for the years ahead. The operator decides how much labor to use and the enterprises on which it will be used. Livestock is kept for the purpose of increasing the income from farming. There are several kinds of livestock on most farms. The operator has the responsibility of deciding annually or oftener which kinds are likely to make best use of the available feed commodities and return the largest income to the farm business. Decisions are required yearly on the emphasis to put on the respective crops to be grown and whether to raise or buy certain feeds required by the livestock. Which fields will be benefited most by an application of barnyard manure or other fertilizers? Shall pasturage be supplemented by grain fed to dairy cows or to cattle that are being fattened? Endless and ever-recurring are the problems of this nature that arise in the operation of a farm and for which the operator must find a solution.

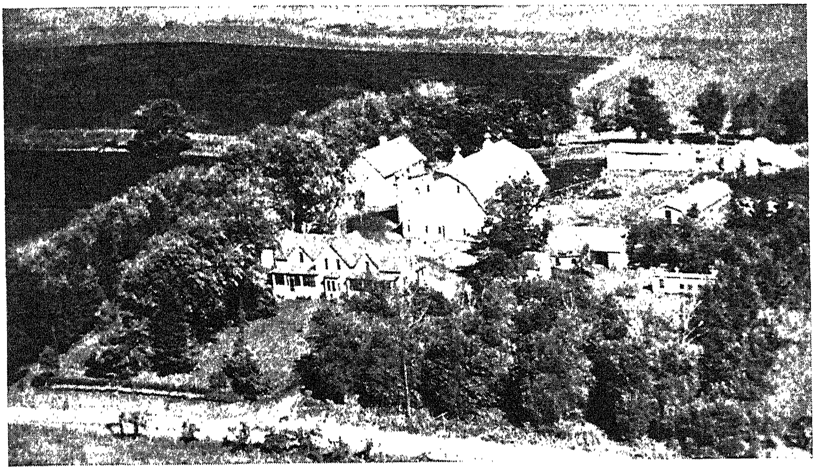

Figure 1. A well-established and orderly farm unit. The ambition of every farmer to maintain good order and earn a satisfactory income requires a high degree of operating skill.

Besides these production activities, there are maintenance problems to watch and provide for as well as the financial and business decisions that must be made from time to time and, in some types of farming, almost daily. The market gardener who sells on the open market or the livestock producer must watch market demands and prices closely or sell at a disadvantage. The buying also is done by the operator. It is important to buy wisely and only so much as can be paid for without limiting needful activities in other ways. In fact, successful operation may be quite as dependent upon wise buying and selling as upon large production.

AGRICULTURE A DYNAMIC INDUSTRY

Agriculture is a dynamic industry. Change is the rule rather than the exception. Few farm operations are performed in the same way or with the same kind of equipment used even twenty-five years ago. Some changes come slowly and almost imperceptibly. Others come with great rapidity, forcing new methods of operation that may render obsolete much of the old equipment. The development of the combine for harvesting crops gives an example of rapid change in methods of operation that affect both the financial investment and the use of labor. The development of strains of hybrid corn by plant breeders has greatly changed corn-growing methods and increased the yield per acre. A smaller acreage, therefore, may yield the production required, releasing other acres for some other desired crop or commodity.

No matter how well a farm may be organized, changes will inevitably be required from year to year. The operator must be alert, informed, and foresighted, in order to anticipate coming changes and modify his operations to meet them. American farmers have produced in the past large quantities of wheat, much of it for export to other countries not so favorably situated for wheat production. At present, because of nationalistic tendencies, unfavorable trade relations, lack of buying power, and war, buying of wheat by other nations is limited and farmers are forced to grow less wheat or sell what they do grow at a loss. Reduction of the cotton acreage in the South is leading to the growth of more corn, grass, and livestock than in the past. The farmers of the Corn Belt and of the dairy region, who have supplied meat and dairy products in large quantity to the people of the South are thus meeting greater competition in the sale of the products on the southern markets. Other examples of change might be given, but these are enough to show that the operator of a farm must be constantly alert to conditions, not only on his own farm, but in the great agricultural areas of the world.

FUNDAMENTALS OF GOOD OPERATION

The farm operator is much concerned with plant and animal life. The plants form the source of subsistence for the animals. Out of one, or both, comes not only food for subsistence of the farmer and his family, but the cash income for living expense, the payment of debts, and the purchase of the desired necessities and luxuries that the family enjoy. The basis for success in agricultural production lies in a wide knowledge of the laws of nature and particularly of those dealing with plant and animal life. It is well known among farmers that some have the knack of always having good yields and good quality crops. Other farmers are noted for high production records from their cows or for raising large litters of high-quality pigs. Others may excel in producing some other product that commands a premium.

These facts are not the result of chance. They arise rather from knowing the life habits of the plants and animals, and in the varying degrees of skill with which the essential elements for growth and well-doing are supplied. The production of plants and animals is essentially a biological process. One having a thorough knowledge of the natural laws governing the processes of plant and animal breeding and of the elements of plant and animal nutrition has a decided advantage in the production of crops and animals. That knowledge will be reflected in better crops and animals only if applied in the everyday activities of the operator responsible for the enterprise. The *will to do* what *should be done* is quite as important to the success of the farm operator as the knowledge of what should be done. Knowledge can not benefit anyone unless it is used. The operator determines whether or not knowledge shall be used.

Knowledge of Economic Laws Important. In these days of commercialized farming, where the farmer sells much that he produces and buys from others many of the things used by his family, knowledge of the laws of economics is helpful to the farm operator. The law of supply and demand, when not disturbed by interference usually influences and determines prices. Large production is usually offset by lowered prices. Large numbers of meat animals will, likewise, eventually result in declining price levels. Because of the working of this law, long and short-time swings in price levels for most commodities may be observed. Fortunately, not all swings in price levels occur at the same time or within the same year. By studying market reports and the frequently published government "outlook reports" it is possible to anticipate shortages of certain commodities and prepare to take advantage of favorable prices. Likewise, it is often possible to avoid producing crops or products of which a large surplus is in store and which is almost certain to sell at a low price. By correct timing in the production and preparation of products for market one can often obtain a short-time advantage in market price which means the difference between loss or profit. The shrewd operator offers his goods for sale when a price advantage can be obtained.

Farming Not an Exact Science. Farming can never be reduced to an exact science or to routine procedure because of the many variables involved. These variables create many problems for the operator. A few may be mentioned.

Much of the farm labor is performed by the operator and his family. The daily tasks must be assigned to those best able to carry the load. Few of the family beside the operator can give full-time service. At some tasks a half-grown boy can do a man's work. At others he may be of little value. In chore work children can be used to some advantage where mature judgment is not required or where it can be directed by a mature supervisor. Some operators are much more successful than others in using child labor. The same may be said in regard to hired labor. In fact, hired labor may vary quite as much as children in skill and ability. To get full service from the labor available to the individual farm is one of the important tasks of the operator.

Variations in Power. Power may be supplied by horses, by internal combustion engines, or by electric service. On many farms a combination of these power services may be wise. In most cases the engine power should be portable and probably in the form of a suitable-sized tractor for field duty. Not all horses are equally powerful. The number kept and the number used on an implement will be dependent upon their size and power. How many and when are matters of judgment for the operator to exercise. The efficiency of horses is often determined by the feed and care they get, and by the manner in which they are handled when at work. The attention given them is controlled by the operator. Tractors are more nearly standardized than horses; yet, there are differences in power, adaptability, and ease of operation, even though given the same power rating. Like horses, their efficiency is determined by the care given them and the skill with which they are operated. Here, again, the operator is responsible.

Weather Variable. The weather is of considerable concern to the farm operator. Not that he can do anything to change it, but because it does much to affect his operations. His first thought in the morning and his last at night is likely to be of the weather and changes in plans that he may have to make on account of it.

It affects not only the growth of his crops but of his animals. And it changes, too, the routine of his daily work and the efficiency with which many of the tasks can be performed. Ability to foretell or judge the weather and to prepare alternate use for labor which must be supported, rain or shine, is a distinct asset to a farm operator.

Decisions Important. Making correct decisions is the most important duty of a farm operator. Often the decisions must be quickly made. They can be wisely made only if the operator has anticipated the need for them and has at his leisure or from previous experience evolved an alternative course of action. A change in the weather at midday may necessitate changing the orders given in the morning. An emergency may arise at any time that will call for treatment entirely opposite of what had previously been thought best. Illness of a member of a crew or an unexpected absence may involve reassigning tasks to all the workers in order to avoid neglect of an important project.

FUNDAMENTALS SUMMARIZED

The fundamentals of good operation and management may be summarized as follows:

1. Constant alertness is a first requisite. To recognize an opportunity to save labor, to improve a product, to reduce production cost, or to gain a market advantage will add to the net return from farming.

2. Foresight is indispensable to successful operation. To see the possibility or threat of trouble and to avert it before it starts or has done damage is the mark of a good operator. It is equally helpful to see opportunities ahead for gain or more successful operation. Plans adjusted to meet an opportunity may also increase returns from operating.

3. "Knowledge is power," is one of the axioms of long ago. Its truth is nowhere more in evidence than in farm operation. To know the nature and growth habits of the wide range of plants and animals coming under the operator's management is no small responsibility. Upon that knowledge depends the success of many ventures in production. Knowledge of human relationships and behavior and of business transactions must supplement knowledge of crops and animals to complete the equipment of the operator.

4. Experience is the handmaid of knowledge. It is gained by first-hand contact with the everyday affairs of the farm. The boy

who is fortunate enough to have been reared on a farm will gain experience by degrees in a way that will serve him well. The boy who has not lived on a farm will be wise to work on a farm under the direction of someone else before trying to operate on his own account. Experience gained without guidance is likely to prove a dear teacher.

5. Good judgment is the capstone of any business enterprise. Some persons are born with it, others acquire it by study, knowledge gained from experience, and by correcting former mistakes of judgment. No matter how gained, it is essential to the greatest possible success. The alert, foresighted, well-informed, experienced operator, who is blessed with good judgment and exercises his talents is well on the way to being a successful farm operator.

THE OBJECTIVE IN FARM OPERATION

Few farmers really define the objective of their farming operations. Most of them, if asked, would probably say that it is to make a living for themselves and their families. And, in a general way, that is perhaps the correct answer, but a somewhat more accurate and specific definition of the objective can be stated. The real objective of a good farm operator is *to get the maximum returns in satisfactions and net profits* from a *minimum expenditure of resources and human labor.* That objective gained puts the operator and his family in a position to live comfortably and to enjoy a good standard of living. It can not be gained, however, without meeting certain requirements which vitally affect both the expenditure of resources and the returns gained from the expenditure.

Know the Details. The first requirement is an *accurate knowledge* of the effect of everyday changes and actions that make for expense or income. This knowledge may be gained from the records kept of cash receipts and expense, from a comparison of inventory gains and losses, and from studies of the production records of crops and livestock. It is taken for granted that one wishing to farm successfully will provide and use one of the easily available record books designed to give a complete account of the year's transaction. One can not correct mistakes unless one knows the source or causes of them.

Avoid Risks. To avoid risks is a second requirement. Farming is attended by many risks. Some are beyond the control of the operator and must be left to chance. Others are within his control if foresight, knowledge, and good judgment are used.

In crop-growing the risk of low yield or crop loss can be avoided by the proper preparation of the soil and seed bed for the crop to be raised. Plant-disease risks can be reduced by suitable crop rotations that lessen the chances of infection from soil borne spores or bacteria. They can be further reduced by suitable seed treatment before planting and by sprays during the growing processes. Insect pests can be controlled in many instances by sprays or poisoned bait. Danger from flooding may be reduced by providing drainage ditches or tile lines, and the effects of drouth can often be reduced by good tillage methods. Plants must be fed if satisfactory growth is to be made. It is unwise to expend seed and labor on land low in fertility unless supplemental plant food is provided in the way of manures or fertilizers. Further risk can be avoided by the selection of crop varieties that will mature in a normal season. Disease-resistant varieties are often available at a slight premium over common varieties. Their use is good insurance against losses from disease. Perhaps enough instances have been cited to illustrate how vital a part

Figure 2. The good operator plans his work and often seeks advice from others.

the operator plays in successful crop production, but the list of remedies is by no means complete. The efficient and resourceful operator will find many more ways to reduce the risks in crop production.

There is little use in growing crops unless they can be safely harvested and securely stored. Matured crops are always subject to injury by hail or bad storms. The sooner after maturity they can be harvested, the less the risk. A day's delay may mean serious damage to quality or complete loss in some instances. Hay and grain are often cured in the field and stacked when dry. Unless carefully handled, there may be loss and damage in the curing process or in the stacks. Well-built stacks or stacks protected by waterproof covering will preserve the product indefinitely, though still subject to injury by heavy winds or by fire. Even in the barn or granary there is risk of loss from rodents, vermin, and leakage from bins. All such losses can be reduced or avoided by the careful, foresighted operator.

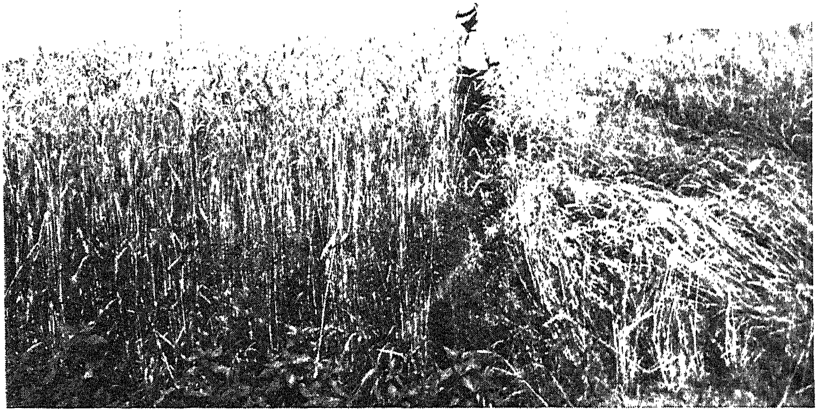

Figure 3. Resistant (left) and (right) nonresistant varieties of wheat. Stiff-strawed, disease-resistant varieties of crop plants are widely available and offer means of reducing crop loss.

Livestock production also is beset with risks, some of which at least can be controlled or reduced. It is often noted that accidents to livestock are much more frequent on some farms than on others. This fact may be due to a number of causes. Among the most common ones are poorly designed buildings, faulty floors, whether of wood or cement, or yards and paddocks improperly laid out and carelessly fenced. Barbed-wire entanglements rather than fences are too frequently found around barnyard enclosures. These often result in trapped colts with cut feet or legs, and in split teats or ugly wounds on valuable cows or other stock. As with crops, there are disease risks in livestock production. Here, also, foresight and good management can greatly reduce them. Clean barns and yards and careful disinfection of diseased animals and quarters, with isolation of contagious or infectious cases, are necessary. Sanitary measures followed in feeding and management, even to the management of pastures, will pay big returns in animal health. It is easier to let these matters go, but the profits and satisfactions, unfortunately, are likely to go with them, if neglected.

Insurance Against Losses. It is not possible to avoid all risks entirely. There are certain risks, however, that can be covered by moderately-priced insurance which, in event of loss by fire, tornado, or other calamity, will yield at least partial compensation for the loss sustained. Crop-insurance contracts are quite commonly available, either through farmers' co-operative insurance companies, old-line insurance companies, or through the provisions of the crop insurance offered by the Federal Government under the authority of the United States Department of Agriculture. While in the long run the cost of insurance just about equals the indemnities paid, it is good policy to carry reasonable coverage with a view to sharing the risk and gaining the advantage of ready cash for replacement, should loss occur.

Prevention of waste is also a function of a good operator. There is some waste under the best of conditions. Under a careless operator the waste may equal or cancel the profits. Some of these wastes may well be noted to illustrate how they occur. A look around most farms will reveal plenty of them. An inspection of mangers and feedboxes will indicate something of the efficiency of the feeder and his knowledge of the requirements of his charges. Hay tramped under foot does the animals no good. Too much hay is not only wasteful of feed, but it is injurious to horses. Grain left in the feedbox after feeding indicates illness or poor condition of the animals or overfeeding. The full value of the feed is not recovered in any case. Sour feed, moldy hay, and weathered fodder are other sources of loss. Corn tramped into the mud in the hog yard would yield more pork if fed on a dry feeding floor. Unused skimmed milk, ungathered and dirty unsalable or unusable eggs are also sources of loss. The fields often show unharvested crops or grain wasted from poor cutting or shocking. Only little things, you say? Yes, but the old Scotch proverb still holds, "Mony a mickle makes a muckle." Waste may kill the profits.

MANAGEMENT OF LABOR AND POWER

Labor is one of the first costs in most farm operations. The farmer does not always recognize his own labor nor that of his family as a cost, because it is seldom paid for in cash. The labor performed by the family, however, is paid for indirectly by the food they eat, the shelter at their disposal, and the clothing and other commodities provided from the farm income. The time of the operator has value and should be wisely used. The expectation is that he should earn at least as much from working on his farm as he could earn if employed for a cash wage by some other farmer or in some other business or industry.

Employ Labor Productively. The use and management of labor is one of the most important functions of the operator. It must be employed as largely as possible on those projects or farm enterprises that will yield income in cash or in commodities for use. Labor expended in caring for growing crops, or livestock, in milking cows, or in feeding and caring for pigs or chickens is said to be employed productively. That is, the crops grown or the commodities made will produce income for the operator, because there will be something to sell or use from its employment. On the other hand, labor expended in mowing lawns, painting buildings, and tidying up the farmyards and fences is not expected to yield income or at most only an indirect income not available for use. Such employment is said to be nonproductive because it does not bring usable or expendable income.

Estimates based on studies of farm costs over a period of years indicate that 40 per cent or more of the cost of growing small-grain crops is for labor. Over 50 per cent of the cost of growing corn or potatoes is labor cost, and hay-crop costs are in nearly as high proportion. Livestock production costs may be largely controlled by the operator. Efficient labor employed on highly productive stock may pay good returns. Expended on low-producing animal units, it may pay very low returns. For instance, labor used on dairy cows yielding 300 to 400 pounds of butterfat per year will earn a good income. The same labor spent on cows giving 200 pounds or less annually will earn little or no income. Frequently the product made from poor cows is worth less than the feed cost, and no wage whatever is earned for the labor expended. The operator will do well to center his attention on the application of available labor to the highly productive enterprises of his farm and to limit as far as possible the amount of labor expended upon low-return or nonproductive enterprises. Studies of profitably-operated farms show, as will be seen later (Chapters III and IV), that farm income is derived largely from well-directed and well-distributed labor on productive enterprises from which good wages and good profits are earned throughout the year. Good farming and good management of labor are closely bound together.

Machinery Replaces Hand Labor. American farmers use power machinery and implements generously in their farming operations. Power and machinery inventories run high on modern commercialized farms. The object is to do, with power and machinery, work that was formerly done by horses and hand labor. Incidentally, it is hoped that costs of production may thus be lowered or more work accomplished. Power and machines, as with labor, can be profitably used only when fully employed on productive enterprises. Whether or not to buy a tractor, a corn husker, or a feed grinder, depends on the work there is for the tractor or the machine to do. Only the operator of the individual farm can determine what the chances are that the investment will pay returns. One should figure the costs for doing the work without the machine and with it. And the costs in interest, depreciation, and repairs for the machine should not be overlooked. These will have to be covered if the machine is to pay its way. To buy a tractor or other expensive machine, because the neighbors have one, is not the answer to the problem. Machines in the long run are paid for by the productive work they do. If they are to add anything to the net farm income, there must be productive employment for them.

Timing the Operations. *On time* at the *right time* should be the aim of the operator. There is a *best time* for nearly every important farm operation. Labor can be saved in crop-growing by timely preparation of the soil. Throughout the Northwest early-seeded crops give the best yields. Early seeding can not be accomplished unless plans are made and the seed bed at least partially prepared the fall before. The one who waits until seeding time to put his machine in order and clean his seed grain will find that he is not on time with his seeding. A day or two of delay in starting the cultivators often means a tough battle with weeds before the end of the season. A few hours' delay in the hay field may mean spoiled hay and poor feed. So one might go through the numberless operations connected with growing crops and point out instances of loss due to *failure* to be *on time.*

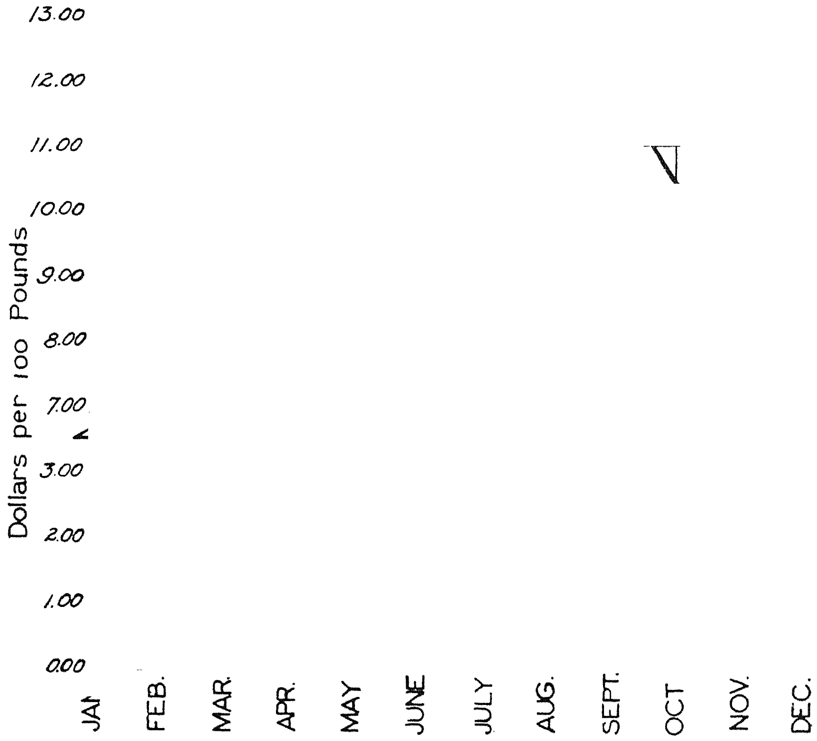

Figure 4. Good and choice grade 200-220-pound hog prices at Chicago by months during 1937. July, August, and September were the most favorable months for marketing.

It is just as important to be on time with the livestock enterprises. The program for livestock production should be planned well in advance. If it calls for winter dairying, breeding operations must be so timed as to bring the cows into milk in the late fall or early winter months. Every good dairyman knows the importance of correct timing and regularity in feeding and milking dairy cows. The same logic applies to hog-raising. Studies of market and outlook reports will enable one to so time pig farrowings as to bring sale stock into the market at a favorable price period. Delays in docking lambs, dehorning calves, or castrating young males intended for market, not only increase the death risks, but often affect adversely the marketability of the stock. These matters all lie within the control of the operator. Some farmers succeed better than others because they look ahead farther and so time their operations and activities as to give them the greatest possible advantage in labor or feed savings and in meeting market demands.

KEEPING THE FARM IN ORDER

Everyone admires a well-kept farm. While appearances do not always indicate the earning power of the farm, they do tell a great deal about the operator. And they also affect the sales value of the farm. The buildings need not be large or pretentious, but they should be neat and well kept. Hinges are provided for doors to swing on. It does not take a skilled mechanic to tighten the screws or bolts that hold them in place or to replace one if broken. It is surprising, too, what a few drops of oil applied to a rusty hinge or bolt will do in easing the swing or stopping noise. Windows are put in barns to let light in and keep cold out. Light will enter through the hole left by a missing or broken pane of glass, but so will the cold. Winter or summer, broken window lights indicate shiftlessness and lack of care. These attentions and adjustments are not must jobs, nor do they promise any returns in income. They can be done at odd times, on rainy days or in slack times at very little expense. The reward will be found in the satisfaction growing out of operating a well-kept farm. There is sale value also in a good reputation for the farm. Neat fences are safer for livestock enclosed and improve the appearance of the farm. Clean fields and roadsides add to the reputation of the farm and reduce the cost of operating. Noxious weeds left to spread reduce yields, increase the cost of operating, and depreciate the selling value of the farm. Finally, painted well-appointed buildings are always attractive to passers-by and a source of pride, comfort, and satisfaction to those who own or operate the farm. Even if new paint can not be provided, cleanliness, neatness, and good order can be in evidence.

As may be seen from the foregoing discussion, farming is divided into two phases, *organization* and *operation*. The first has to do with the long-time or permanent layout of the farm, the type of farming to be followed, and the proportions and relationships of the parts that make up the farm unit. The second phase relates more particularly to the short-time or immediate plans and to the everyday activities involved in farming. Farm organization was fully treated in *Agriculture II.* Attention will be given in the following chapters to matters leading to efficient farm operation.

Suggestive Questions

1. What is the difference between farm organization and farm operation?
2. Why is farming not an exact science?
3. What are the major variable factors in farming?
4. What is the difference between productive labor and maintenance labor?
5. What are some of the risks a farm operator must take?

Suggestive Activities

1. List the farms in the section in which your farm is located and indicate which ones are operated on a good organization plan.
2. Make a survey of 25 farms and list the tractors by power, make, and age.
3. By inquiry at local insurance offices and at the County Agricultural Agent's office learn the kinds of insurance that can be carried on farm property.
4. Classify the farms visited in making the tractor survey on the basis of their general appearance as (1) well kept, (2) fairly well kept, and (3) poorly kept.

CHAPTER II

DETERMINING THE RESULTS FROM OPERATION

A farmer can know the success with which the operation of his farm is conducted only through a careful review of the year's work. Has he successfully carried out the plans he had laid for the year? Has he made any financial progress? Have his earnings been sufficiently large to permit him to make savings during the year or has he had to draw upon past savings in order to pay his personal and living expenses? How large have his earnings been? The answer to these questions and many others can be obtained most easily and accurately if records have been kept during the year. The more complete the records, the better the answers can be given. The records for the Southeast Minnesota Dairy Farm discussed in *Agriculture II* will be used again to illustrate the method of determining the results from operation.[1]

COMPARISON OF INVENTORIES

An inventory taken at the beginning of the year and again at the end of the year will provide much valuable information that will be useful in analyzing the success of the past year's operations. The time required to take a good inventory is so small that all farmers should find time to take one each year. A discussion of the methods used in taking an inventory and a pattern form was presented in *Agriculture II.* That pattern inventory is repeated in Table I. The quantities and value of the property on hand at the end of the year have been added.

Changes in the Farm Assets. The total value of the farm assets, as presented in Table I, was $18,313.78 at the beginning and $18,034.33 at the end of the year. This is a decrease of almost three hundred dollars, which is the net result of increases in the value of some assets and decreases in others. A detailed analysis of the inventory will indicate more accurately the nature and importance of this change.

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[1] The individual student should use the data obtained from his project farm during the year and make an analysis similar to the one presented in this and the next chapter.

TABLE I—Pattern Inventory of a Southeast Minnesota Dairy Farm

WHOLE FARM *(land and buildings)* *Description*	*Number of Acres*	*Price per Acre*	*Value at Beginning of Year*	*Value at End of Year**
Name of Farm, **Oak Grove**				
Legal Description:	159.6		$12,500.00	$12,303.00
(1) Total Farm Operated (land and buildings)			$12,500.00	$12,303.00

Buildings, Fencing, etc.	*Original Cost*	*Year Built*	*Value at Beg. of Yr.*	*Value at End of Yr.*
(2) House operator lives in			$3,200.00	$3,100.00
Barn			1,260.00	1,225.00
Cement stave silo			380.00	365.00
Hoghouse No. 1			285.00	275.00
Hoghouse No. 2			55.00	50.00
Poultry house			120.00	125.00
Granary			700.00	670.00
Double corncrib			210.00	235.00
Garage and machine shed			450.00	430.00
Windmill			85.00	80.00
Tanks, pumps, etc			125.00	120.00
Barbed-wire fence			140.00	140.00
Woven-wire fence			62.00	60.00
(3) Total, buildings and improvements			$7,072.00	$6,875.00
(4) Land (1) minus (3)			5,428.00	5,428.00
(5) Farm buildings, etc. (3) minus (2)			3,872.00	3,775.00

Machinery and Equipment Description	*Size*	*Year Bought*	*Beginning of Year*		*End of Year*	
			No.	*Value*	*No.*	*Value*
Chrysler sedan		1930	1	$200.00	1	$150.00
Dodge touring		1924	1	35.00	1	30.00
Gas engine	10 h.p.		1	47.00	1	45.00
Gas engine	9 h.p.		1	22.00	1	21.00
Gas engine	2½ h.p.		1	14.00	1	13.00
Electric motor	½ h.p.		1	9.00	1	9.00
Gasoline (gal.)			35	5.85	55	9.08
Grease (lbs.)			5	.50	29	2.10
Gang plow	2-14″		1	11.00	1	10.00
Sulky plow	16″		1	9.00	1	8.50

(Continued)

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* This column is provided for the purpose of recording the inventory at the end of the year. By including both inventories on the same form, comparisons of the items can most easily be made. The farm account books recommended provide columns for both the opening and closing inventories. In some of them, provision is made for recording property jointly owned with a neighbor or tenant. Having the items listed in an orderly manner and in full is a safeguard against missing any of the items in taking subsequent inventories.

TABLE I—PATTERN INVENTORY OF A SOUTHEAST MINNESOTA DAIRY FARM—*(Continued)*

Machinery and Equipment Description	*Size*	*Year Bought*	*Beginning of Year*		*End of Year*	
			No.	*Value*	*No.*	*Value*
Walking plow	14″		1	$9.00	1	$8.50
Spiketooth harrow			1	9.00	1	8.50
Disc	7′		1	18.00	1	17.75
Spring-tooth harrow			1	17.00	1	16.00
Field drag			1	19.00	1	18.00
Rotary hoe			½	45.00	½	43.00
Spring wagon			1	9.00	1	8.00
Buggy			1	17.00	1	16.00
Wagons			3	83.00	3	79.50
Trailer			1	14.00	1	13.00
Bobsled			1	50.00	1	50.00
Manure spreader			1	65.00	1	63.00
Hayrack			2	35.00	2	35.00
Corn planter			1	49.00	1	45.00
Corn cultivator	2-row		1	47.00	1	45.00
Corn binder			1	50.00	1	60.00
Corn sheller			1	9.00	1	8.50
Silage cutter			1/5	23.00	1/5	23.00
Corn shredder					¼	60.00
Seed racks				5.00		5.00
Grain drill	7′		1	10.00	1	10.00
Grain drill		1938			1	50.00
Grain binder	7′		1	52.00	1	45.00
Fanning mill			1	12.00	1	11.00
Potato machinery				96.00		92.00
Hay mower	5′		1	31.00	1	34.00
Dump rake			1	23.00	1	22.00
Side-delivery rake			1	32.00	1	32.00
Hay loader			1	38.00	1	36.00
Forks and slings				10.00	1	10.00
Double harness			3	52.00	3	60.00
Misc. horse equipment				27.00		26.50
Cream separator			1	80.00	1	70.00
Milking machine			1	250.00	1	245.00
Pans, cans, scales, etc.				16.00		20.50
Hog feeders, waterers, and oilers				28.00		26.00
Incubators and brooder stoves				10.00		19.00
Brooder houses			1	34.00	1	30.00
Fountains, feeders, etc.				8.00		8.00
Stover mill	8′		1	29.00	1	30.00
Tank heater			1	7.00	1	6.00
Sacks				9.00		9.00
Scales				2.00		2.00
Miscellaneous tools				32.00		32.00
Total Power, Crop and General Machinery and Equipment				$1,814.35		$1,846.43

(Continued)

TABLE I—Pattern Inventory of a Southeast Minnesota Dairy Farm—*(Continued)*

Feeds and Seeds Description	*Beginning of Year*			*End of Year*		
	Quantity	*Value per Unit*	*Total Value*	*Quantity*	*Value per Unit*	*Total Value*
Ear corn	550 bu.	$0.50	$275.00	663 bu.	$0.45	$298.35
Oats	431 bu.	.28	120.68	344 bu.	.24	82.56
Spring wheat	71 bu.	.95	67.45	71 bu.	.60	42.60
Barley	42 bu.	.43	18.06	300 bu.	.36	108.00
Oats and barley	391 bu.	.33	129.03	140 bu.	.30	42.00
Oats and wheat	316 bu.	.40	126.40	621 bu.	.33	204.93
Alfalfa, timothy, and clover	13.1 T.	8.00	104.80	15.7 T.	6.00	94.20
Phalaris, timothy, and clover	4.2 T.	7.00	29.40	8.0 T.	5.00	40.00
Shredded stover	5.0 T.	1.75	8.75	4.0 T.	1.50	6.00
Silage	40.2 T.	2.50	100.50	37.0 T.	1.75	64.75
Soybean meal	184 lb.	1.80	3.31	1,600 lb.	1.65	26.40
Linseed meal	560 lb.	2.30	12.88	25 lb.	2.15	.54
Mineral feed	100 lb.	2.75	2.75	15 lb.	3.00	.45
Oyster shells	100 lb.	.90	.90	100 lb.	1.00	1.00
Salt	125 lb.	1.76	2.20			
Potatoes	30 bu.	.50	15.00	40 bu.	.50	20.00
Seed corn	15 bu.	1.50	22.50	11 bu.	1.50	16.50
Timothy seed	100 lb.	3.50	3.50			
Alfalfa and timothy seed				90 lb.	10.00	9.00
Twine	45 lb.	.10	4.70	24 lb.	.08	1.92
Fall plowing	62.5 A.	1.25	$78.12	57.0 A.	1.25	$71.25
Total feeds and seeds			$1,125.93			$1,130.45

Horses	*Beginning of Year*			*End of Year*		
Description or Name	*Age*	*Weight*	*Value*	*Age*	*Weight*	*Value*
Colonel	16		$115.00	......		......
Dan	16		115.00	17		$ 90.00
Belle	19		120.00	20		90.00
Kernel	8		155.00	9		155.00
Silvia	16		60.00	17		50.00
Charley	5		145.00	6		145.00
Dewey	3		125.00	4		155.00
Colt	1		35.00	2		50.00
Total value of work horses			$835.00			$685.00
Total value of colt			35.00			50.00
Total value of all horses			870.00			735.00

(Continued)

The buildings are now one year older than when the first inventory was taken, and are worth somewhat less. This decrease in value, or depreciation, during the year can be calculated by dividing the value at the beginning of the year by

TABLE I—PATTERN INVENTORY OF A SOUTHEAST MINNESOTA DAIRY FARM—*(Continued)*

Cattle		*Purebred*	*Beginning of Year*			*End of Year*		
Description	*Breed*	*or Grade*	*Age*	*No.*	*Value*	*Age*	*No.*	*Value*
No. 1	Hols.	Grade	10		$ 50.00	3		$ 55.00
2	"	"	4		60.00	5		60.00
3	"	"	9		45.00	3		50.00
4	"	"	5		60.00	6		60.00
5	"	"	6		60.00	7		55.00
6	"	"	5		60.00	6		60.00
7	"	"	8		60.00	4		55.00
8	"	"	7		64.00	4		60.00
9	"	"	6		65.00	7		60.00
10	"	"	4		55.00	5		55.00
11	"	"	6		60.00	7		60.00
12	"	"	3		50.00	4		55.00
13	"	"	8		60.00	3		60.00
14	"	"	7		60.00	8		55.00
15	"	"	6		65.00	7		65.00
16	"	"	5		60.00	6		60.00
17	"	"	7		60.00	8		55.00
18	"	"	3		50.00	4		55.00
19	"	"				3		55.00
Other cattle								
Bull			2	1	60.00			
Heifers			2	5	225.00	2	1	45.00
Heifers			1	4	120.00	1	5	150.00
Calves				5	75.00		9	142.00
Total dairy cows					$1,044.00			$1,090.00
Total other cattle					480.00			337.00
Total all cattle					1,524.00			1,427.00

Hogs and Poultry	*Beginning of Year*			*End of Year*		
Description	*Lbs.*	*No.*	*Value*	*Lbs.*	*No.*	*Value*
Hogs:						
Boar Duroc Jersey Grade	275	1	$ 20.00	350	1	$ 20.00
Sows " "	1,750	7	157.00	1,900	8	156.75
Fall pigs " "	2,200	22	165.00	4,480	32	291.20
Spring pigs " "				400	40	20.00
Total hogs	4,225		$342.00	7,130		$487.95
Poultry:						
Hens White Leghorn		250	$137.50		190	$104.50

(Continued)

the expected life of the building. For example, this farmer estimated that with only a minimum of repairs the house would last for about thirty years. Dividing the value at the beginning of the year, $3,200, by thirty gives an annual depreciation of about $100. The value of the house has, therefore, fallen to $3,100 at

TABLE I—PATTERN INVENTORY OF A SOUTHEAST MINNESOTA DAIRY FARM—*(Concluded)*

Summary of Inventory

Classes of Property	*Value at Beginning of Year*	*Distribution of Capital Per Cent*	*Value at End of Year*	*Distribution of Capital Per Cent*
Land	$5,428.00	29.5	$5,428.00	30.1
Buildings and improvements	7,072.00	38.7	6,875.00	38.1
Power, crop and general machinery and equipment	1,814.35	9.9	1,846.43	10.3
Feeds and seeds	1,125.93	6.2	1,130.45	6.3
Horses	870.00	15.7	735.00	15.2
Cattle	1,524.00		1,427.00	
Hogs	342.00		487.95	
Poultry	137.50		104.50	
Value total physical farm assets	$18,313.78		$18,034.33	

the end of the year. An average rate of depreciation is 2 per cent for stone and brick buildings and 3 per cent for frame buildings. The poultry house and the double corncrib have been repaired during the year, so that they are now worth more than at the beginning of the year. The cost of the repairs was added to the beginning inventory before subtracting the depreciation for the year. In spite of the repair work done on these two buildings, the total value of all buildings has decreased by almost two hundred dollars during the year. Since the land is apparently in the same condition as at the beginning of the year, its value has not been changed.

Most of the machinery is older, in poorer condition, and, therefore, worth less than at the beginning of the year. The depreciation for the year is calculated in the same way as for buildings. For many machines, particularly tractors and large machines, consideration must also be given to the trade-in value. The depreciation for the year can be calculated by dividing the difference between the present value and the trade-in value by the expected life of the machine. Some machines have been repaired, maintaining or increasing their value. A grain drill and a fourth interest in a corn shredder have been purchased. The total value of all machinery is slightly greater than at the beginning of the year.

More feed is on hand at the end of the year than at the beginning. More feed was raised during the year than was needed by the livestock. But, since feed prices are lower than at the beginning of the year, the value of that feed is no greater.

One old horse died during the year, and the value of the three oldest horses has decreased materially. There has been an increase in the value of the two young horses, although this is not as large as the decrease in the value of the old horses. There is one more cow at the end of the year than at the beginning, although several of the old cows have been replaced by heifers. The number of young cattle is the same as at the beginning, although a larger proportion of these cattle are young calves. The value of the hogs on hand is larger than at the beginning of the year, while the value of poultry is slightly smaller.

In the analysis presented in Chapter VI of *Agriculture II* it was suggested that this farmer should increase the number of dairy cows. According to this inventory, he has made little progress towards achieving this objective. He has one more cow than at the beginning of the year, to be sure, but he has fewer two-year-old heifers and only the same number of yearling heifers as at the beginning of the year. Since a few of the cows are now quite old and will have to be sold in a year or two, it will be at least two or three years before he can materially increase the number of cows except by purchase. He apparently could have kept a few more cows during the past year, for his livestock did not use all the crops that were produced.

The total value of livestock other than horses, of feeds and seeds, and of machinery and equipment is the same at the end of the year as at the beginning. But the value of the buildings and of the horses has decreased. The value of the buildings is decreasing with age. Unless the condition of the buildings is maintained by constant and extensive repairs, savings must be set aside in other ways or this farmer will find in a few years that a large part of the investment in his farm has disappeared, and he will have nothing to show for it. Buildings will have to be replaced, and he will not have adequate funds. The same situation is true in regard to horses.

Change in the Farmer's Net Worth. The comparison of inventories must be extended to assets and liabilities other than those used in the operation of the farm in order that the analysis may be most valuable. The summary of all assets and liabilities of this farmer is presented in Table II. In addition to the assets used in the operation of this farm, he owns shares of stock in a co-operative creamery and in a co-operative elevator as well as some other outside property. The value of these assets has not changed during the year. The value of the household goods and clothing is the same as at the beginning of the year. The wear and tear on the old goods has been offset by the addition of new goods. The cash surrender value of the farmer's life insurance has been increased by $50, and the cash on hand or in the bank has been increased from $73 to $352.

TABLE II—NET WORTH STATEMENT SOUTHEAST MINNESOTA DAIRY FARM

Item	*Value at Beginning of Year*		*Value at End of Year*	
Assets:				
Physical farm assets (Table I)	$18,313.78		$18,034.33	
Stock in co-operative creamery	100.00		100.00	
Stock in co-operative elevator	100.00		100.00	
Outside property owned	500.00		500.00	
Household and personal goods	900.00		900.00	
Cash surrender value of life insurance	325.00		375.00	
Cash on hand and in bank	73.00		352.00	
Total assets		$20,311.78		$20,361.33
Liabilities:				
Note at bank	$ 1,000.00		$ 1,000.00	
Owing on corn shredder			39.00	
Total liabilities		$ 1,000.00		$ 1,039.00
Net worth		$19,311.78		$19,322.33

The total value of all assets owned by this farmer has increased very slightly during the year. The nature of that investment, however, has changed but little. The value of the farm assets has decreased by almost three hundred dollars, due largely to the decrease in the value of the buildings and the horses. This has been more than offset by the increase in savings in the form of insurance and cash on hand or in the bank.

His liabilities have increased slightly during the year. He still owes a note at the bank. In addition he has not yet paid for the corn shredder which was purchased during the year. These liabilities represent claims which other persons hold against his assets. The difference between the assets and the liabilities, or his net worth, is the only value which this farmer can really call his own. This farmer has increased his net worth very slightly during the year. Since his net worth has been increased, his earnings must have been sufficiently large to cover all the personal and living expenses for himself and his family and still permit him to add a small amount to savings.

DETERMINATION OF EARNINGS

The comparison of the net worth at the beginning and at the end of the year, however, does not indicate clearly the amount of the earnings. The net worth could have increased slightly with low farm earnings, if the family lived very frugally. Even with high earnings the net worth might be low, if the family maintained a very high and expensive standard of living. An additional analysis will be needed in order to determine the earnings. A satisfactory measurement of the earnings is needed in order to measure accurately the success of the year's operation. It is also needed in order to determine most effectively opportunities and methods of improving the business.

Record Forms to Use. Numerous good farm account books are available from the agricultural experiment stations in many states. Complete directions for keeping the farm record are given in most of these books. Forms for use in calculating the earnings with directions for their use are usually included. Farm accounting will be easiest and most valuable, if one of these books is used.

The records of farm receipts and expenses, to be used in the calculation of earnings and in the analysis of the business, should include only those items which pertain directly to the farm business. Personal and living expenses should be recorded separately. The personal and living expenses are not part of the cost of operation of the farm; they are paid out of the earnings of the farm.

One form for use in the calculation of earnings which has been found to be satisfactory is presented in Table III. The data included in the Table are for the southeast Minnesota dairy farmer. The data are for the same year as the summary of inventories in Table I. The method of calculation of earnings and of analysis of the earnings statement will be illustrated by the use of this record.

What the Summary of Receipts Shows. The total value of the farm sales made during the year was $3,842.07. Slightly more than one half of this was obtained from the sale of dairy products and of cattle. Slightly more than one fourth was obtained from the sale of hogs. This combination of enterprises,

TABLE III—Summary of Receipts, Expenses, and Earnings Southeast Minnesota Dairy Farmer

	FARM SALES:	
	Dairy products	$1,120.03
	Cows	322.92
	Other cattle	465.77
	Hogs	1,059.12
	Poultry	93.31
	Eggs	408.47
	Crops	66.61
	Income from work off farm	112.34
	Miscellaneous	12.70
	Agricultural conservation payment	180.80
(1)	Total farm sales	$3,842.07
(2)	Farm produce used in house	286.93
(3)	Rental value of house	315.00
(4)	TOTAL FARM RECEIPTS (sum of 1, 2, and 3)	$4,444.00
	FARM PURCHASES:	
	Cows bought	$ 154.00
	Other cattle bought	33.00
	Hogs bought	10.00
	Poultry bought	42.50
	Feed for livestock	209.90
	Other livestock expense	36.70
	Crop expense (seed, twine, fertilizers, etc.)	293.31
	Hired labor	112.82
	Buildings and fences (new **7.00**) (repairs **84.27**)	91.27
	Machinery (new **146.75**) (repairs and expense **125.98**)	272.73
	Tractor (hired)	85.31
	Auto (farm share)	55.15
	Electricity (farm share)	29.66
	Taxes	219.44
	Insurance on buildings and livestock	93.46
	Miscellaneous	21.80
(5)	Total farm purchases	$1,761.05
(6)	Decrease in farm inventory	246.45
(7)	TOTAL FARM EXPENSES (sum of 5 and 6)	$2,007.50
(8)	RETURNS TO CAPITAL AND FAMILY LABOR (4-7)	$2,436.50
(9)	Interest on farm inventory at 5%	902.50
(10)	**FAMILY LABOR EARNINGS** (8-9)	1,534.00
(11)	Estimated value of unpaid family labor	1,440.00
(12)	**OPERATOR'S LABOR EARNINGS** (10-11)	$ 94.00

dairy cattle and hogs, has been very satisfactory in southeastern Minnesota. The sale of poultry and eggs contributed approximately one half of the remainder of the total value of all sales. The income from the sale of crops, work done away from the farm by the regular farm labor, power, and machinery, the agricultural conservation payment, and the sale of miscellaneous farm items contributed the remaining 10 per cent of the value of all farm sales.

This is a livestock farm. The crops raised must be those which will produce a large quantity of feed nutrients at a low cost. Since dairy cattle and hogs are the principal sources of income, special attention must be paid to them in order that production may be as efficient as possible. Although the poultry are not as important as dairy and hogs on this farm, they contribute sufficient income to require considerable study and attention.

Part of the production of the farm during the year has been used in the home instead of being sold. Livestock, livestock products, vegetables, fuel, and the house have been supplied to the family. The quantities and the values of the farm products used in the house are listed in Table IV. The total value of these products, using the price that would have been received had they been sold, was $286.93. The cost would have been considerably higher if they had been purchased. In addition to these products, the farm has also supplied a house for the farm family. A fair rental value can be calculated as 10 per cent of the average investment in the house. This 10 per cent covers interest on the investment, depreciation, upkeep, taxes, and insurance. Since the average of the opening and closing inventories is $3,150, the rental value is $315. The total value of the farm products and of the rental value of the house, (called the farm perquisites) is $601.93. This is part of the production of the farm and must be included with the farm receipts in calculating the earnings. The value of the perquisites is an important part of the farm income, being equal to 15 per cent of the value of all sales on this farm.

TABLE IV—FARM PRODUCE USED IN HOUSE

Item	*Amount*	*Butterfat*	*Value*
Milk	1,922 qts.	144.68 lbs.	$ 48.35
Cream*	116 pts.	41.95 lbs.	12.16
Eggs	132 doz.		22.94
Other poultry, 59 head	176 lbs.		21.16
Hogs, 4 head	1,050 lbs.		74.42
Potatoes	47 bu.		22.90
Fruit and vegetables	....		35.00
Farm produced fuel	....		50.00
Total	....	....	$286.93

* Butter used by the family was obtained from the creamery which made a cash deduction from the cream check for the amount used monthly.

On some farms there may be an increase in inventory during the year. Some of the livestock raised during the year may not have been sold. Some of the crops produced during the year may still be on hand. A large share of the value of items purchased during the year, as a grain drill or a tractor, may still be on hand at the end of the year. This increase in inventory should be included with the receipts. There is no such increase in inventory on this farm for the year shown in the record.

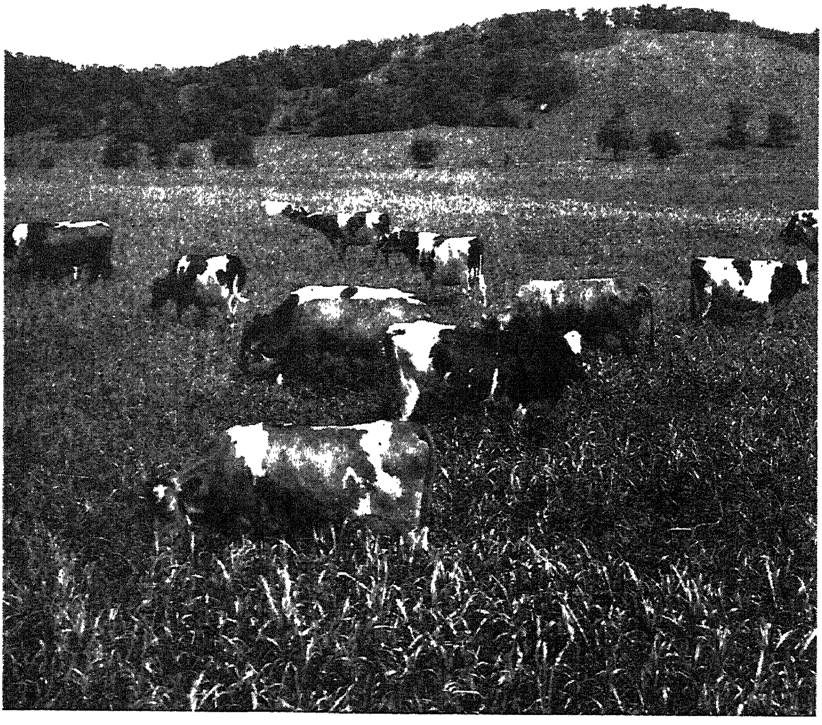

Figure 5. A herd of good dairy cows produce steady income. On a group of Minnesota dairy farms approximately one half of the income was from the dairy herds. Very little fertility is sold from the farm in dairy products.

The total receipts for the year, the sum of the value of the farm sales and the perquisites, are $4,444.00. Although this value is fairly large, it is not unusual for successful farms. On 122 successful dairy farms in this community during this same year, the average value of the farm receipts was $6,388.[1]

What the Summary of Expenses Shows. The total value of all farm purchases made during the year was $1,761.05. One fourth of these expenses pertained directly to livestock. Some cattle, baby chicks, and a half interest in a boar were purchased. Bills for veterinary service, horseshoeing, cow testing, fly spray, and other miscellaneous livestock items had to be paid. Some feed, principally poultry concentrates and high-protein feeds for the hogs and cows were purchased. These livestock expenses do not seem to be unreasonably high. The cows were purchased to replace the old ones which were sold. The feed purchases were small compared with those made by other successful farmers in the community. With efficient livestock the use of purchased feeds to supplement the home-grown feeds may materially increase the farmer's earnings.

Figure 6. Good thrifty hogs supplement the dairy herds and add another one fourth to the farm income.

The purchases of seeds, fertilizers, twine, and other crop expenses, not including threshing, silo filling, and shredding bills, totaled $293.31. These expenses were quite high because a large quantity of legume seeds was purchased during the year.

Since the supply of family labor was large, little labor was hired. Some day labor was hired during rush seasons.

Expenses for buildings, machinery, and mechanical power are important on many farms. These expenses on this farm amounted to $534.12, or almost one third of the total purchases.

These included the purchase of new items, repairs and upkeep on the old, gasoline, oil, and grease, and the threshing, silo filling, and shredding bills. Although this expense is high, it is not unusually high for dairy farms in this area. A more detailed analysis of this expense, such as will be made in the following chapter, will be needed in order to determine more exactly whether or not this expense is too high.

Taxes were quite high on this farm—$1.37 per acre. This, however, is an expense over which the farmer has little or no control. The insurance cost is very high on this farm.

Part of the expense of operation of the farm, however, is not represented by a direct outlay. Buildings, machinery, and equipment have been used during the year. These were paid for some time in the past and will not be replaced until some time in the future. But the value of these items is gradually disappearing. This depreciation, or decrease in the value of the farm inventory, should be charged against the current year's operation. The decrease in the inventory can be determined from Table I. In the calculation of farm earnings, only the farm share of the value of the automobile, truck, and light plant should be included with the farm inventory. Since 40 per cent of the automobile mileage was used for farm purposes, only 40 per cent of the $55 depreciation on two automobiles or $22 is charged against the farm. With this correction the total decrease in inventory on this farm during the year was $246.45.

The value of board and room supplied to hired men should also be charged against the farm. There was no such charge on this farm.

The total expense for the farm, including purchases and decrease in inventory, was $2,007.50. This was quite low compared with other dairy farms in this community. The average farm expenses for 122 successful dairy farms in this community during this same year was $3,998.00.

The Returns to Investment and Family Labor. The difference between the farm receipts and the farm expenses is the return which remains from the year's operation as payment for the use of the farm investment and for the labor and management given by the family. This is the return from the farm which the family can use to pay the living expenses, pay interest and principal on debts, and to add to savings. Unless some income is available from other sources, this is the only income which is available for paying those expenses. The total farm receipts for the southeast Minnesota dairy farmer were $4,444.00, and the total farm expenses were $2,007.50, leaving $2,436.50 as return for the use of the farm investment and the family labor.

The operator's labor earnings were low on this farm. The returns from the year's operation of the farm were just slightly more than enough to pay 5 per cent interest on the investment and hired man's wages for the work done by the children. The average operator's labor earnings for 122 successful dairy farms in the same year were $1,024, or almost $1,000 higher than was obtained by this southeast Minnesota dairy farmer. Only 25 farmers had smaller earnings than this farmer. The capital and labor on this farm apparently were not used as effectively as may have been possible.

Suggestive Questions

1. What information can be gained from a complete farm inventory?
2. What is a net worth statement?
3. How is it made?
4. Why is a decrease in inventory charged as expense?
5. How are "family labor earnings" determined?
6. What is meant by "operator's labor earnings"?

Suggestive Activities

1. Complete the end of the year inventory for your project farm.
2. Summarize the inventory and make a net worth statement for your farm.
3. Summarize the receipts and expense for your farm for the year and calculate the net returns for the use of capital and labor.
4. Determine the family labor earnings.
5. Calculate the value of "unpaid family labor" on your project farm and determine the "operator's labor earnings."

CHAPTER III

MEASURING THE EFFICIENCY OF OPERATION[1]

The progressive farmer is not satisfied with merely determining the success of the year's operations. He wants to know whether or not he could have been more successful. Was the farm effectively organized? Was it efficiently operated? Could there have been some room for improvement during the year? A careful examination of the comparative inventories and of the earnings statement reveals much valuable information. But he will wish to make analyses more thorough than is possible from these statements alone. Here, again, adequate records will help him to make a quick, accurate analysis.

Variations in Earnings. There are wide variations in earnings among farmers in any community. Some farmers may be very successful, while their neighbors may be suffering large losses. This variation in earnings is illustrated graphically in Figure 7. This graph summarizes the labor earnings of a group of southeastern Minnesota dairy farmers in 1938. Each bar represents one farm, and the height of the bar represents the operator's labor earnings. A few of those farmers obtained very high earnings, while a few suffered large losses. The earnings for most of them varied within a range of approximately $2,000. Although the range from the highest to the lowest is somewhat greater than is usually obtained, the proportion of the distribution is typical of that in most communities.

Factors Affecting Earnings. A large proportion of this variation in earnings is due to factors under the farmer's control. Farm management studies made in many states indicate the principal factors responsible for this variation. These factors can be grouped into four classes, (1) size of business, (2) choice of crops and of livestock, (3) efficiency in production of crops and livestock, and (4) efficiency in the use of labor, power, machinery, and buildings.

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[1] The data from the Southeast Minnesota Dairy Farm is again used to demonstrate a method of measuring the efficiency of operation. Students should use similar data from their project farm and by a careful study of it determine in what respects the operation of the farm can be improved.

A farmer studying his business should analyze each of these factors very carefully. Most of the calculations involved are relatively simple, and the time required for the work is not very great. The principal requirement is that the farmer be interested in improving the income from his farm.

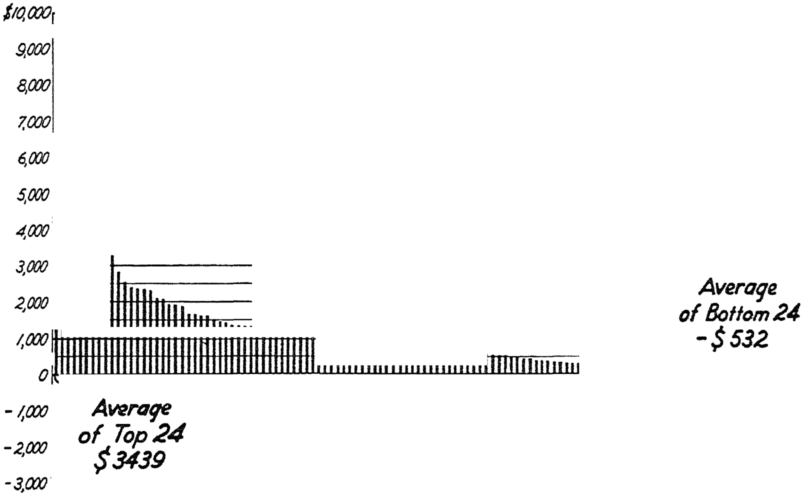

Figure 7. Range in earnings of co-operators, Southeast Minnesota Farm Management Service, 1938. The top fifth of these farmers averaged about $4,000 more per man than the bottom fifth.

SIZE OF BUSINESS

One of the most important factors affecting farm earnings is size of business. In years when farmers are receiving normal returns from their operations, the returns tend to be largest for those farmers who have the largest volume of business. This relationship of earnings to size of business is illustrated in Table V. Costs of machinery and buildings do not increase in proportion to the size of the farm. Labor and power can generally be used more efficiently on large farms. More favorable prices can frequently be obtained when buying or selling in large quantities. In years when most farmers suffer losses, however, farmers with the larger business tend to have the larger losses. Farm records obtained by the various agricultural experiment stations reveal very few years in which farmers with a large volume of business have lower earnings than those with a small business.

Although the larger farms tend to have larger earnings, it is not necessarily true that all farmers can increase their earnings by increasing the size of their business. Some farmers are able to work effectively themselves but are not able to direct the work of others effectively. They can not plan the work and operate the farm efficiently unless they do all the work themselves. Such men should not increase the size of the business, but they must expect to receive smaller earnings than those farmers who are able to operate large farms.

TABLE V—RELATIONSHIP OF OPERATOR'S LABOR EARNINGS TO SIZE OF BUSINESS[1]

*Size of Business, in Per Cent of Average**		*Number of Farms*	*Average Operator's Labor Earnings*
Range	*Average*		
70 and under	54	314	$ 528
71 to 112	90	737	929
113 to 154	130	265	1,358
155 and over	193	146	1,966

* Size measured in terms of productive man-work units.

The southeast Minnesota dairy farmer, who has previously been used as an example, operated a farm of 160 acres. This is 14 acres less than the average size of the farms in his county. All this land was used for the production of feed crops typical for the community. No intensive crops, yielding a large income per acre, were raised.

Dairy cattle and hogs were the principal livestock raised. The numbers raised were no greater than on other farms of like size in that community. None of the products was of unusually high quality, bringing a special price.

The size of this farm business was, then, approximately equal to the average in the community. Even with very high efficiency of production, it is not likely that the operator's earnings would be extremely high.

SELECTION OF CROPS AND LIVESTOCK

The kinds and proportions of crops and of livestock are also important factors affecting earnings. These factors are a part of the problem of farm organization and as such are discussed in detail in *Agriculture II.* The farmer will, however, wish to review his choice of crops and livestock quite frequently and make such adjustments as are necessary. Changes in economic conditions or in methods of production may make a modification of the farm organization profitable. With the accumulation of information from the farm records, the farmer may be able to analyze his selections more accurately than he could before. Unwise selections of enterprises seriously limit earnings of many farmers.

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[1] Southeast Minnesota Farm Management Service, 1928-1937. This Table and similar Tables in this chapter were prepared from unpublished data of the Division of Agricultural Economics of the University of Minnesota.

TABLE VI—RELATIONSHIP OF OPERATOR'S LABOR EARNINGS TO PERCENTAGE OF TILLABLE LAND USED FOR HIGH-RETURN CROPS[1]

Per Cent of Land in High Return Crops		*Number of Farms*	*Average Operator's Labor Earnings*
Range	*Average*		
25 and under	22	163	$ 603
26 to 31	29	256	850
32 to 37	35	391	871
38 to 43	41	348	1,192
44 and over	50	304	1.514

The important influence of crop selection upon earnings is illustrated in Table VI. The farmers who used a large proportion of their tillable land for crops yielding a high return per acre obtained high earnings relative to the others. It is equally important to select the proper kinds and numbers of livestock.

EFFICIENCY IN CROP AND LIVESTOCK PRODUCTION

Variations in the efficiency of crop and livestock production, as well as variations in the kinds and proportions of crops and livestock grown, are important factors causing variations in earnings among farmers. The farmers with the highest efficiency tend to obtain the highest earnings. It is very important that the farmer analyze carefully the efficiency of his farm operations and maintain high efficiency from year to year.

Crop Yields. Crops represent the basic part of the production program on most farms. The importance of high crop yields is illustrated by Table VII. The operator's labor earnings for the farmers whose crop yields were 33 per cent above the average for the community were $1,075 higher than for those whose crop yields were only 69 per cent of the average.

Most farmers make some calculations of the yields per acre obtained from some of their crops. When they determine the total production of their grain crops at threshing time they frequently calculate their own yields and compare them with those of their neighbors. This comparison will be most valuable if the yields are expressed in terms of bushels of standard weight, as 32 pounds per bushel for oats and 48 pounds per bushel of barley. It is also important that the farmer make similar calculations for his corn, hay, and other crops. If the acreage, total production, and yield per acre for each crop is carefully recorded, comparisons can be made with the results obtained in previous years. Farmers interested in continuous returns from their farms will try to operate in such a way as to maintain or increase their yields.

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[1] Southeast Minnesota Farm Management Service, 1928-1937.

TABLE VII—RELATIONSHIP OF OPERATOR'S LABOR EARNINGS TO LEVEL OF CROP YIELDS[1]

*Crop Yields**		*Number of Farms*	*Average Operator's Labor Earnings*
Range	*Average*		
77 and under	69	184	$ 536
78 to 92	86	355	788
93 to 107	100	445	1,023
108 to 122	115	317	1,284
123 and over	133	161	1,611

* Per cent of the average of all farms.

Comparisons of yields with those obtained by neighboring farmers will be very valuable. Differences in soils among the different farms must be carefully considered. Discussions with neighboring farmers, trying to determine causes for variations, will produce many worth-while suggestions as to methods for increasing yields. The yields per acre obtained by the southeast Minnesota dairy farmer and by 122 successful farmers in the same section of the state are presented in Table VIII. The yields obtained by this farmer were considerably higher than average for the community for all small-grain crops, for corn, and for phalaris hay. The yield of alfalfa was somewhat lower than the average. The yields obtained by this farmer were quite satisfactory. Although it would still be desirable for him to consider possibilities for further increasing the level of his yields, he must carefully consider the costs involved in doing so.

Livestock Efficiency. Livestock is an important part of the production program on many farms. High efficiency in livestock production is desirable on such farms. This importance can be illustrated by the high butterfat-production per cow on dairy farms in southeastern Minnesota. The relationship of the operator's labor earnings to butterfat production per cow is presented in Table IX. The farmers whose cows averaged 337 pounds of butterfat realized earnings twice as high as those farmers whose cows averaged only 166 pounds. Within limits, the cost per pound of butterfat tends to decrease with increased production per cow.

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[1] Southeast Minnesota Farm Management Service, 1928-1937.

TABLE VIII—CROP YIELDS PER ACRE ON THE SOUTHEAST MINNESOTA DAIRY FARM AND ON 122 NEAR-BY FARMS

Crop	*Yield Per Acre*	
	Southeast Minn. Dairy Farm	*Average of 122 Farms*
Oats	46.4 bu.	35.9 bu.
Barley	39.7 bu.	28.2 bu.
Oats and barley	54.1 bu.	35.1 bu.
Oats, barley, and wheat	36.1 bu.	30.5 bu.
Wheat	18.3 bu.	14.2 bu.
Ear corn	56.7 bu.	51.7 bu.
Silage corn	9.0 tons	8.9 tons
Alfalfa, timothy, and clover	1.4 tons	2.4 tons
Alfalfa and timothy	1.9 tons	2.1 tons
Timothy and clover	1.1 tons	1.4 tons
Phalaris hay	3.4 tons	2.5 tons

TABLE IX—RELATIONSHIP OF OPERATOR'S LABOR EARNINGS TO BUTTERFAT PRODUCTION PER COW[1]

Pounds Butterfat Per Cow		*Number of Farms*	*Average Operator's Labor Earnings*
Range	*Average*		
189 and under	166	237	$ 698
190 to 229	210	390	950
230 to 269	250	449	1,043
270 to 309	287	279	1,268
310 and over	337	107	1,430

TABLE X—METHOD OF CALCULATING AVERAGE NUMBER OF COWS[2]

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
First of month	18	17	17	17	17	16	16	17	17	16	16	17	201
Purchased	—	—	—	—	1	—	1	—	—	—	—	1	
Heifers fresh*	—	—	—	—	—	—	—	—	—	—	2	2	
Sold	1	—	—	—	2	—	—	—	1	—	1	1	
Butchered	—	—	—	—	—	—	—	—	—	—	—	—	
Died	—	—	—	—	—	—	—	—	—	—	—	—	
Last of month	17	17	17	17	16	16	17	17	16	16	17	19	202

Total 403

Average number for year—403÷24=16.8 cows

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* Heifers dropping their first calf.

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[1] Southeast Minnesota Dairy Farm.

[2] Southeast Minnesota Farm Management Service, 1928-1937.

The analysis of the efficiency of livestock production requires the determination of the average number of head of each class of livestock for the year. This average can be easily calculated for those farmers who have carefully recorded the dates and numbers of all livestock changes during the year. The method of calculation is illustrated in Table X. The average number of cows on the Southeast Minnesota Dairy Farm was 16.8.

The net increase or decrease in value of any class of livestock can be calculated in the same way by using values instead of weights. The method of calculation is illustrated by the following data for dairy cows on the Southeast Minnesota Dairy Farm:

Beginning inventory	$1,044.00	Sold	$ 322.92
Purchased	154.00	Butchered	......
Heifers fresh	230.00	Ending inventory	1,090.00
Total	$1,428.00	Total	$1,412.92
		Decrease in value	$ 15.08

For feeder cattle, feeder lambs, hogs, turkeys, and other livestock sold largely by weight the quantity of production can best be measured in terms of the pounds of marketable livestock produced. The method of calculation is illustrated by the following hog data for the southeast Minnesota dairy farmer:

Beginning inventory	4,225 lbs.	Sold	13,540 lbs.
Purchased	75 lbs.	Butchered	1,050 lbs.
Total	4,300 lbs.	Ending inventory	7,130 lbs.
			21,720 lbs.

Marketable hogs produced: 21,720 lbs.—4,300 lbs.=17,420 lbs.

Of the total weight of hogs sold, butchered, or on hand at the end of the year, a portion was on hand at the beginning of the year or was purchased during the year. The difference between these two items is the weight of the hogs produced during the year. Transfers of animals from one class to another, as the transfer of cows to or from the feed lot, are included in the record in the same manner as purchases or sales.

There was a depreciation in the dairy herd of $15.08, or $0.90 per cow. Such a decrease in the value of dairy herds is to be expected, since good dairy heifers tend to cost more than they will bring for beef when sold as cull cows.

The production of butterfat (or milk) per cow and eggs per hen is an important part of the efficiency of production of the dairy and the poultry enterprises. According to the records of the southeast Minnesota dairy farmer, he sold 3,908 pounds of butterfat, used 187 pounds in the home, and fed 160 pounds in whole milk to the calves. The total production of butterfat on the farm was then 4,255 pounds, or 253 pounds per cow. This is considerably higher than the average production of all dairy cows in the state, and 13 pounds above the average production per cow for 122 successful dairy farmers in southeastern Minnesota. The eggs produced per hen can be calculated in the same way.

The value of the dairy products of each cow can be calculated in the same way as the pounds of butterfat produced by substituting values for pounds. Calculated in this manner, the value of dairy products produced per cow on the Southeast Minnesota Dairy Farm was $84.74. Subtracting the $0.90 depreciation per cow leaves a net production per cow of $83.84.

The costs of production must also be considered in analyzing efficiency of production. High rates of production or large gross returns per unit will not increase net earnings if they are obtained at very high costs. Feed cost is usually the most important cost factor in livestock production. It represents from 50 to 80 per cent of the total cost of livestock production. Although other costs are also important, the farmer's opportunities for effecting savings are less than with the feed costs. The labor, equipment, and buildings are usually available on the farm. The principal problem is merely to utilize those resources to the best advantage. There are usually important alternative uses for the feed. The feeds fed to one class of livestock may be used by another or they may be sold.

The return over feed cost is an important measure of livestock efficiency. The gross return per dairy cow on the Southeast Minnesota Dairy Farm was $83.84; the feed cost was $33.74, and the return over feed cost was $50.10. This is the return which remains as pay for the labor, for the use of buildings and equipment, and to pay veterinary and other dairy production costs.

There are many other valuable data that can be calculated from adequate records. The quantities of feed used per head or per hundredweight produced will provide information which can be effectively used in planning improvements in livestock production. The per cent of protein in the ration, the price received for products sold, and other data will be helpful.

These data will be most valuable if they are recorded in a neat, logically arranged Table, with data for consecutive years. An arrangement of data pertaining to the dairy enterprise that has been found to be useful is presented in Table XI. The data for the Southeast Minnesota Dairy Farm for three consecutive years are included in this Table. Butterfat production per cow has been fairly high each year, although it was lowest in the second year in which this farmer kept records. The quantity of feeds fed per cow has been increased somewhat although the per cent of protein in the feed has been very low each year. It would probably be profitable for this farmer to readjust his rations to provide more protein. The provision of more legume hay would help to provide this protein. Since the quantity of silage fed is very large on this farm, it would probably be profitable to substitute legume hay for some of the silage. The return over feed cost has been quite high each year; but there has been a very satisfactory return left to pay for the labor, equipment, buildings, and other cost items used in dairy production.

TABLE XI—Factors of Cost and Returns in Dairy Production[1]

Item	*First Year*	*Second Year*	*Third Year*
Pounds of butterfat per cow	260	226	253
Feed per cow, pounds:			
Corn	325	37	41
Small grain	738	835	1,139
Commercial feeds	48	150	128
Legume hay	1,313	1,769	1,386
Other tame hay	598	1,038	1,003
Corn stover	860	888	1,059
Silage	8,578	6,988	9,420
Total concentrates	1,111	1,022	1,308
Total dry roughage	2,771	3,695	3,448
Total digestible nutrients	3,574	3,650	4,136
Total digestible nutrients per pound butterfat	13.7	16.2	16.4
Per cent protein in ration	10.1	11.1	11.1
Feed cost per cow:			
Concentrates	$ 17.35	$ 17.34	$ 16.80
Roughages	13.71	18.32	13.90
Pasture	3.40	2.66	3.04
Total feed cost	$ 34.46	$ 38.32	$ 33.74
Value produced per cow:			
Butterfat sales	$ 87.21	$ 63.82	$ 65.94
Dairy products used in house	3.69	3.97	3.41
Milk fed to other livestock	16.14	16.49	15.39
Increase in value of cows	1.50	.40	.90
Total value produced	$108.54	$ 84.68	$ 85.64
Return above feed cost per cow	$ 74.08	$ 46.36	$ 51.90
Price received per lb. butterfat sold	35.7c	30.6c	28.7c
Feed cost per lb. butterfat	13.3c	17.0c	13.4c

Equally valuable forms can be prepared for each of the other classes of livestock. The numerous publications of the different state experiment stations, the United States Department of Agriculture, and other sources will provide useful suggestions concerning measures that may be calculated. A large proportion of those items should be in physical terms, as pounds of feed or per cent of protein. Since these are comparable from year to year, such measures will be very valuable.

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[1] Southeast Minnesota Dairy Farm.

EFFICIENCY IN USE OF LABOR, POWER, MACHINERY, AND BUILDINGS

The cost of labor, power, machinery, and buildings represents a large proportion of the costs of operating a farm. The efficient use of these factors has an important bearing on the farmer's earnings. Increased efficiency in their use will lower the cost per unit of output and increase the profit.

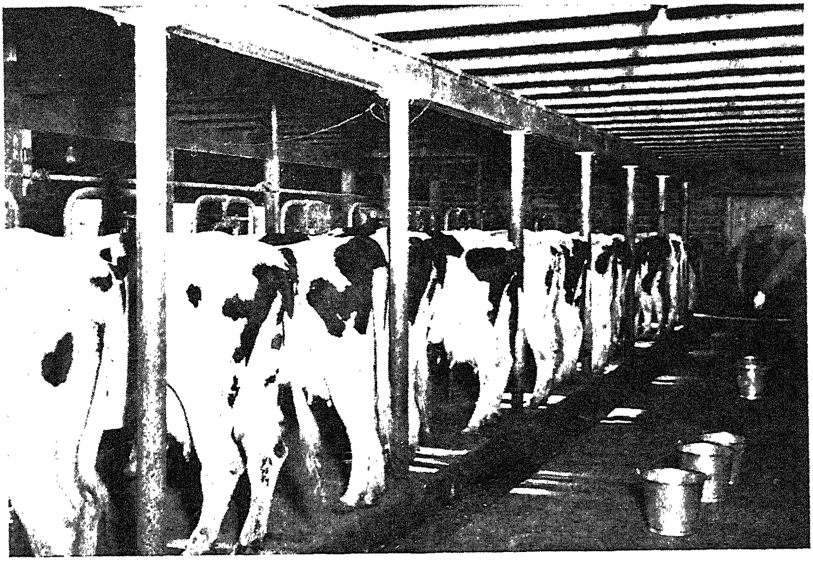

Figure 8. A barn must be well filled with productive livestock to permit good returns on the investment.

Labor. Labor must be efficiently used during the year. Work must be well planned in order that each task may be completed quickly and well and that little time may be lost in going from one task to the next. Each worker must apply himself to the task at hand in order that he may not waste any time and that all the essential parts of his task may be done on time.

But it is not sufficient that the workers keep themselves busy and perform their tasks quickly. A large proportion of their time must be spent on tasks which will increase the income from the farm or will eliminate expense which would otherwise be necessary. An unnecessarily large amount of time spent in maintenance of buildings, fences, and machinery and in tidying up the place may improve the appearance of the place, but it will not increase the financial return.

The southeast Minnesota dairy farmer operated a farm slightly smaller than the average for his community. The number of livestock kept was about equal to that on other farms of the same size. He utilized labor equivalent to three full-time men, or almost one man more than was used on other farms of the same size. The quantity of crops and the number of livestock cared for by each worker was low compared with those of other farmers.

Power, Machinery, and Buildings. Efficiency in the use of power, machinery, and buildings is as important as efficiency in the use of labor. The cost of these items per unit of output must be as low as possible. The annual cost for each of these items can be calculated by the use of a form similar to that used in calculating the return from livestock. The method of calculation is illustrated in Table XII. The cost of power on this farm was $536.52. It included the cost for horses as well as for mechanical power. The total cost of power used for crop work—hired and horse—was $414.67, or $3.67 for each acre of harvested crops. The costs for machinery and buildings were somewhat lower than those for power.

PRICES

The prices paid for products purchased and the prices received for products sold are also important factors affecting the farmer's earnings. These prices vary considerably among farmers. The average prices for the year can be calculated very easily. The average price for the year is the total value divided by the total quantity.

Several factors influence the average price received for products sold. There are variations in the prices paid in different markets. There are also variations in the prices paid at different times of the year. The farmer who sells the largest proportion of his products at the season when prices are highest will tend to show the highest average price for the year. Part of the variation in prices among farmers is due to differences in the qualities of the products that are sold. Similar factors affect the prices of products that are purchased.

TABLE XII—CALCULATION OF ANNUAL COST OF POWER, MACHINERY, AND BUILDINGS[1]

Item	*Debits*			
	Beginning Inventory	*Purchases*	*Repair, Upkeep, Gas, Oil, Feed, Hired, etc.*	*Total*
Hired Power	....	....	$ 85.31	$ 85.31
Auto*	$ 100.35	....	55.15	155.50
Gas Engines*	83.00	....	20.87	103.87
Electricity*	9.00	....	29.66	38.66
Horses	870.00	....	194.36	1,064.36
Total Power	1,062.35	....	385.35	1,447.70
Machinery	1,481.00	$146.75	105.11	1,732.86
Buildings and Fences	7,072.00	7.00	84.27	7,163.27

Item	*Credits*				*Net Cost*
	Ending Inventory	*Sales*	*Income from Rental*	*Total*	*Debit—Credit*
Hired Power	....	....	....	....	$ 85.31
Auto	$ 83.18	....	$ 5.00	$ 88.18	67.32
Gas Engines	79.00	....	....	79.00	24.87
Electricity	9.00	....	....	9.00	29.66
Horses	735.00	....	....	735.00	329.36
Total Power	906.18	....	5.00	911.18	536.52
Machinery	1,567.25	....	....	1,567.25	165.61
Buildings and Fences	6,875.00	....	110.00‡	6,985.00	178.27

* Farm share only.
‡ Depreciation and upkeep on the farm dwelling.

YOUR FARM COMPARED WITH OTHERS

The analysis of the farm business will be most valuable and accurate if the effectiveness of the organization and efficiency of operation is compared with that of other farms. This comparison should be made with farms operating under similar conditions. The performance of other farms will provide a standard for comparison. Is this farm organized and operated as well as other farms in the community? If not, is it possible to make improvements which will increase earnings? Such a comparison with other farms may give many valuable suggestions for improvements and changes.

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[1] Southeast Minnesota Dairy Farm.

Start with General Measures. The analysis of the farm business by comparison with other farms will be most valuable if it is started with a few general measures. These will give a picture of the farm business as a whole. It will indicate the strong and the weak points in the farm business. The analysis can then proceed to the more specific measures. The comparison with other farms permits the use of measures which differ from those which are available when analyzing the individual farm. Special measures will frequently be needed in order to make complex comparisons. A few of the most valuable of these measurements will be presented in this discussion. The measures most valuable to use will vary according to the type of farming.

Size of Business. One of the most valuable measures of size of the farm business is work units (productive man-work units). The number of work units on a farm is the number of 10-hour days that would be required to care for the crops and for the productive livestock (livestock other than the work stock) if the farmer spent the same number of hours per acre of crops or per unit of productive livestock as the average farmer in the community. In the calculation of this measure the average time spent in a year with an acre of crops or one unit of livestock can best be determined from records of a group of farms. This record should be the average for the community. Numerous publications summarizing such records are available from agricultural experiment stations. Knowledge of agricultural conditions in the community will contribute much valuable information. The number of acres of each kind of crop and the number of units of each kind of livestock on a specific farm are then multiplied by these averages. Adding all these calculated labor requirements gives the total work units on the farm.

This measure provides a means of combining enterprises of different kinds into one figure. It takes into account the number of livestock as well as the number of acres of crops. It also takes into account the kinds of crops and kinds of livestock. A farm with a large number of work units is, then, a farm with a large acreage of crops, a large number of livestock, or both.

Crop Selection. The kinds of crops grown can be effectively compared by means of an index of crop selection. In calculating the index of crop selection, the crops grown in the community must first be classified into groups. The factors to be considered in the grouping are: (1) nutrients produced per acre of feed crop, (2) per cent protein in feed crops, (3) cost of producing a unit of digestible nutrients, (4) net return per acre for cash crops, and (5) the effect of the crop on the land. After preparing this classification, the method of calculation is illustrated in Table XIII. The crops grown on tillable land in southeastern Minnesota have been classified into four groups: A, B, C, and D crops. The particular crops which would be included in each of these classes will vary among different areas. In this area, the A crops were given a weight of 1, the B crops ½, the C crops ¼, and the D crops 0. The number of acres of each crop is multiplied by the weight. These weighted acres are then added, the sum is divided by the total acres of tillable land, and the quotient is multiplied by 100.

TABLE XIII—CALCULATION OF THE INDEX OF CROP SELECTION[1]

Crop	*Acres*	*Classification of Crop*	*Weight*	*Weighted Acres*
Oats	17.6	D	0	....
Barley	9.4	B	½	4.7
Oats and barley	9.2	C	¼	2.6
Oats, barley, and wheat	22.0	C	¼	5.5
Wheat	5.4	C	¼	1.4
Ear corn	17.2	B	½	8.6
Silage corn	12.6	C	¼	3.2
Garden and potatoes	1.1	A	1	1.1
Alfalfa, timothy, and clover	4.2	B	½	2.1
Alfalfa and timothy	13.9	B	½	7.0
Timothy and clover	.9	C	¼	.2
Sweet clover and timothy pasture	19.2	C	¼	4.8
Alfalfa and timothy pasture	1.2	B	½	.6
Total	133.9			41.8

Index of crop selection: $\frac{41.8}{133.9} \times 100 = 31.2$

The index of crop selection can be interpreted as the per cent of the tillable land which is used for high return crops. This index on the Southeast Minnesota Dairy Farm was 31.2. The average index of 122 successful dairy farms in this same area was 41.3. This farmer used a far smaller proportion of his tillable land for high return crops than other farmers in this area. He had a less desirable cropping system.

Livestock Selection. No satisfactory comparative measure or index of the kinds of livestock is available at the present time. It is, therefore, difficult to include the analysis of kinds of livestock in this comparison. The analysis on the individual farm must be made in the same manner as was indicated in *Agriculture II.*

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[1] Southeast Minnesota Dairy Farm.

Number of Livestock. When several different kinds of livestock are kept, it is difficult to arrive at a practical comparison unless a relative basis for such comparison is established. The numbers must be expressed in an average common denominator, as it were. All must be reduced to equivalent units. One unit is one mature horse, cow, or the equivalent in other livestock. The number of head of different kinds equivalent to one animal unit is as follows:

1 mature cow or horse
2 colts
1 bull
2 head other cattle under two years
5 sows or hogs, six months or over
10 pigs under six months old
7 sheep, six months old or over
14 lambs under six months old
100 hens

The average number of different classes of livestock and the average number of animal units on the Southeast Minnesota Dairy Farm during the year were:

Work horses	6.4 head	6.4 animal units
Colts	1.0 head	.5 animal units
Cows	16.8 head	16.8 animal units
Bull	.5 head	.5 animal units
Other cattle	11.0 head	5.5 animal units
Hogs	14.6 head	2.9 animal units
Pigs	37.4 head	3.7 animal units
Hens	206.0 head	2.1 animal units
		38.4 Total animal units

The intensity of stocking on the farm can be measured by the number of productive animal units (livestock other than work stock) per 100 acres in the farm. The total number of productive animal units on the Southeast Minnesota Dairy Farm was 31.5. The number of acres in the farm was 160, giving 19.7 animal units per 100 acres. This number is exactly equal to the number on other successful farms in the same community.

Crop Yields. The average level of the yields on a farm can be compared with other farms in terms of its index of crop yields. The method of calculation of this index is illustrated in Table XIV. One hundred sixteen and one tenth acres of crops were harvested on the Southeast Minnesota Dairy Farm. If the yields on this farm had been equal only to the average of other farms in the community, 136.1 acres would have been required to produce the same quantity of crops that was produced on this farm. This is 17 per cent more than the number of acres that were actually required. The crop yields on this farm were, then, 17 per cent higher than the average in the community.

Livestock Efficiency. There are several valuable measures of livestock efficiency. The butterfat produced per cow or eggs produced per hen are useful measures of the efficiency of the dairy and poultry enterprises. The return over feed cost per unit of livestock can be used for all classes. The method of calculation of the return over feed cost has been discussed earlier in this chapter.

TABLE XIV—CALCULATION OF INDEX OF CROP YIELDS[1]

Crop	*Acres on This Farm*	*Yield Per Acre on This Farm*	*Total Production on This Farm*	*Yield Per Acre in Community*	*Acres Required With Average Yield*
Oats	17.6	46.4 bu.	816	35.9	22.8
Barley	9.4	39.7 bu.	373	28.2	13.2
Oats and barley	9.2	54.1 bu.	498	35.1	14.2
Oats, barley, and wheat	22.0	36.1 bu.	794	30.5	26.0
Wheat	5.4	18.3 bu.	99	14.2	7.0
Ear corn	17.2	56.7 bu.	976	51.7	18.9
Silage corn	12.6	9.0 tons	113	8.9	12.7
Alfalfa, timothy, and clover	4.2	1.4 tons	6	2.4	2.5
Alfalfa and timothy	13.9	1.9 tons	27	2.1	12.9
Timothy and clover	.9	1.1 tons	1	1.4	.7
Phalaris	3.7	3.4 tons	13	2.5	5.2
Total acres	116.1				136.1

Index of crop yields: $\frac{136.1}{116.1} \times 100 = 117.22$

Another valuable measure of livestock efficiency is the livestock return for every $100 of feed fed. This measure is sometimes used in place of return over feed cost. The method of calculation can be illustrated with data for the cows on the Southeast Minnesota Dairy Farm. According to the data presented previously in this chapter, the return per cow was $83.84 and the feed cost was $33.74. The return per $100 worth of feed used was then $\frac{83.84}{33.74} \times 100 = \$248.49$.

A Measure of Labor Efficiency. Efficiency in the use of labor can be measured in terms of the number of work units per worker. It is calculated by dividing the total number of work units on the farm by the average number of workers. This measure represents the number of 10-hour days that would be required to take care of the number of acres of crops and the number of units of livestock that were cared for by each man on this farm, if the same number of hours per unit were used as the average for the community.

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[1] Southeast Minnesota Dairy Farm.

Measuring Efficiency in the Use of Power, Machinery, and Buildings. The efficiency in the use of power, machinery, and buildings can be effectively measured in terms of the cost per work unit. The method of calculating the total expense on the farm for these items has been presented earlier in this chapter. By dividing these costs by the number of work units, it will be possible to compare them with the costs on other farms of different sizes.

Sources of Information. The publications of many agricultural experiment stations will suggest many of the factors that could be measured. These publications will usually discuss the methods of calculation and interpretation of these factors. By consulting these publications, the measures which are most applicable to the student's home community can be determined.

Summary of Data. The data which will be used in the analysis of the farm business will be most valuable if they are summarized in the form of a table. These data can then be compared with the average for the community. A comparison with the data for the most successful and the least successful farms in the community will also be very helpful.

The data for the Southeast Minnesota Dairy Farm are summarized in Table XV. These are measures which have been found to be the most useful in the analysis of the business on dairy farms in southeastern Minnesota. The data for 122 farms that were members of the Southeast Minnesota Farm Management Service are also presented in this Table as a basis for comparison. The averages for all 122 farms, for the 20 per cent with the highest earnings, and for the 20 per cent with the lowest are given.

Thermometer Charts. The data contained in the summary Table will be more easily visualized if they are presented in graphic form. Such a graph is known as a thermometer chart. One form of a thermometer chart is presented in Figure 9. The first bar represents the operator's labor earnings. Each of the other bars represents one of the management factors or measures of the effectiveness of organization and efficiency of operation. The average of the group of farmers for which this form was used is represented by the heavy line halfway up the bars. For each factor the highest level attained by any farmer is represented by the top of the bar and the lowest level by the bottom of the bar. The values are so arranged on the bars that the efficiency which is associated with the highest earnings is at the top of the bar.

The averages and the ranges shown by the bars in Figure 9 are those obtained from the analysis of 122 dairy farms in southeastern Minnesota, the same farms that are shown in Table XV. The data for the Southeast Minnesota Dairy Farm are shown by the heavy shading of the bars. The height of the bar represents the value of each particular factor for that farm.

TABLE XV—Measures of Farm Organization and Operating Efficiency[1]

Measure Used	*This Farm*	*Average of 122 Farms**	*24 Most Profitable Farms**	*24 Least Profitable Farms**
Operator's labor earnings	$94	$1,024	$3,439	$-532
Size of business—work units	648	866	1,216	855
Index of crop selection	31.2	41.3	44.0	40.1
Animal units of productive livestock per 100 acres	19.7	19.7	21.1	18.1
Index of crop yields	117	100	110	96
Pounds butterfat produced per cow	253	240	260	231
Return over feed cost per animal unit of productive livestock other than cows	$68	$56	$81	$38
Labor efficiency—work units per worker	216	360	396	325
Power, machinery, and building expense per work unit	$1.36	$1.44	$1.43	$1.64

* Ranney, W. P. and G. A. Pond, *Annual Report of the Farm Management Service for Farmers in Southeast Minnesota for the Year 1938*, Mimeographed Report 104 of the Division of Agricultural Economics of the University of Minnesota, page 12.

What the Thermometer Chart Shows. The size of the farm business of the southeast Minnesota dairy farmer as measured by work units is somewhat lower than the average of other successful farms in this community. This farmer, therefore, had fewer acres of crops or fewer livestock or both. Or the crops and the livestock were of a type which required less work.

The index of crop selection was considerably lower than the average of the other farms. A smaller proportion of the land was used for crops which produced a large quantity of feed per acre at low cost and which helped to build up the fertility of the land. The yield of crops per acre on this farm, however, was considerably higher than the average for the community, as shown by the index of crop yields.

The number of livestock per 100 acres was equal to the average for the community. The efficiency of this livestock was slightly better than average. The butterfat production of the cows was somewhat higher, although the difference was not very great. The return over feed cost per unit of livestock other than

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[1] Southeast Minnesota Dairy Farm.

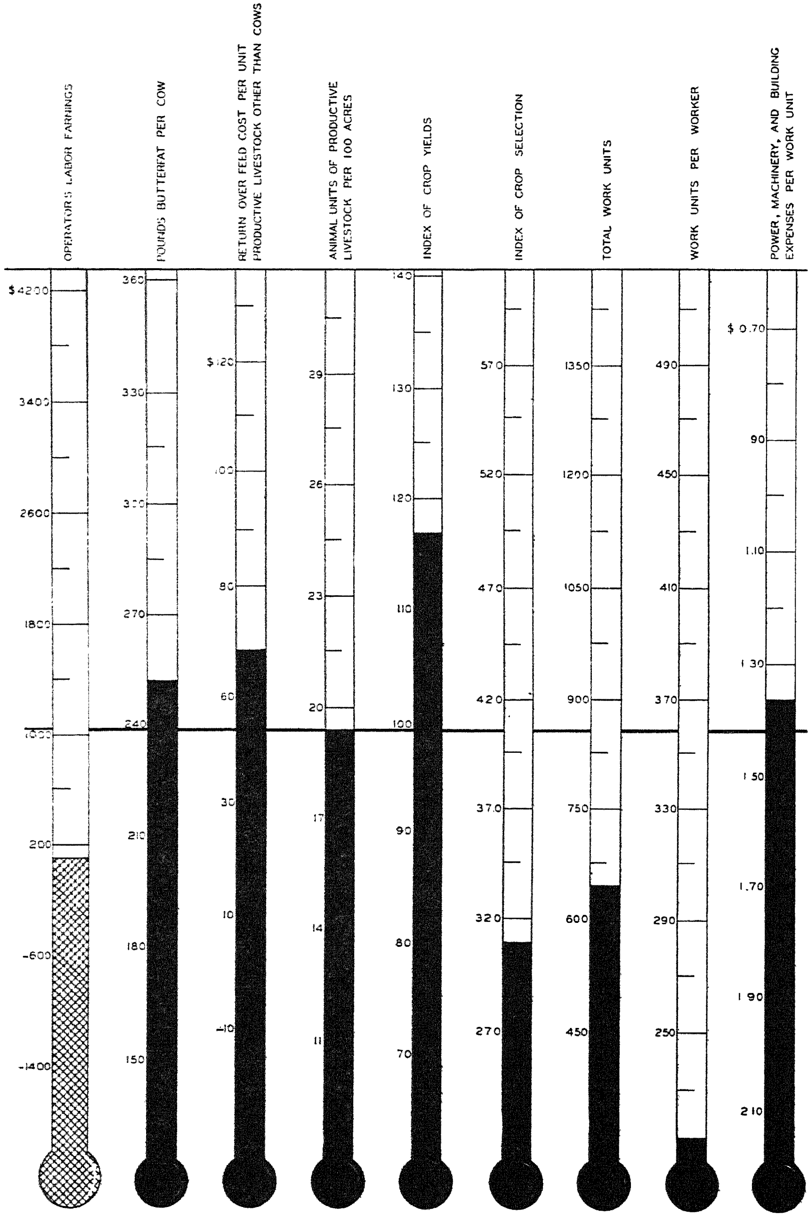

Figure 9. Thermometer chart.

cows was slightly better than average. This farmer converted most of his feeds into livestock and livestock products at an efficiency only slightly better than the average for the community.

Labor efficiency as measured by work units per worker was extremely low on this farm. The number of acres of crops and the number of units of livestock to be cared for by each man was very low. The size of the farm business was not sufficiently large to provide full employment for all the workers. Since the efficiency of production of crops and of livestock was only a little higher than the average of all farms, this large surplus of labor was not effectively used on this farm.

The cost for power, machinery, and buildings per work unit was approximately equal to the average. This farmer apparently had enough power, machinery, and buildings to do effective work on the farm and yet not so much as to show too high a charge for these items.

This analysis has indicated quite clearly the principal reasons why the operator's labor earnings were lower than on other successful farms in the community. Although the efficiency of production of crops and livestock and the efficiency in the use of power, machinery, and buildings was slightly above the average of this group of farmers, the volume of business was too small. There was not sufficient work to keep all the labor profitably employed, resulting in a heavy labor charge for each unit of production. Even if this efficiency in the use of labor had been as high as the average, the volume of business was too small to give high earnings.

In order to increase his earnings materially this farmer must either increase his volume of business to utilize efficiently the labor of all the members of the family or he must use that labor to increase materially the efficiency of production. The volume of business may be increased by obtaining the use of additional land or by increasing the number of livestock on the farm. The reorganization of the farm that was suggested in *Agriculture II* would enable this farmer to keep a larger number of cows without decreasing the number of other livestock. If the efficiency of the livestock could be increased somewhat, it might be profitable to purchase some feeds in order to increase the number of livestock. By additional care and study the efficiency of crop and livestock production could be increased. This farmer must especially guard against the adoption of labor-saving devices which increase the expenses without correspondingly increasing the income. His problem is to increase income, not to save labor.

After making a general analysis such as this, the farmer must make a detailed analysis of each part of the business. How can he increase the volume of business? How can he increase the efficiency of production? The discussion presented in *Agriculture II* and in other chapters of this volume will indicate the problems which must be analyzed in order to answer these questions.

Farm Management Service Associations. Farmers in many states are able to secure aid in keeping and analyzing their farm records through the means of farm management service associations. These are organizations formed jointly by interested farmers and by the state agricultural extension service and experiment station. Each farmer keeps a record of his business in a standard farm record book. These records are summarized at the end of the year by the state agricultural extension service or by the experiment station, and a report summarizing the data for the various farms is prepared.

A field man usually visits each farmer several times each year, helping him with the problems of keeping the records and checking the records for completeness and accuracy. He also discusses with the farmer problems of farm management. After the annual report has been completed, he helps the farmer to interpret the data for his farm. The farmer pays a fee for this service to help defray the cost involved.

Suggestive Questions

1. What are the weak links in your farm organization?
2. What factors limit the efficiency of operation on your farm?
3. How can crop fields be improved?
4. How many animal units are kept on your farm?
5. What is a "man-work unit"?
6. How may livestock production efficiency be measured?

Suggestive Activities

1. Compare the size of your farm business with that of adjoining farms, as measured by total acres and tillable crop acres. Also by man-work units required to operate.
2. Using the data from project farms handled by members of the class as a group make a chart similar to Figure 7 showing the labor earnings from each farm.
3. Using the same data, establish an "average line" on a thermometer chart and compare your farm with it to learn the strong and weak points in your farm business.

CHAPTER IV

MAKING ADJUSTMENTS IN PRODUCTION

The farmer is constantly confronted with the need for making adjustments in the production program. Changes in the weather may make it necessary to change the cropping system from that which was originally planned. Severe drouth may make it necessary to plow up one crop and seed another. Unexpected price relationships may make it profitable to change the type of product which is sold or the time at which it is sold. Low corn prices may make it profitable to feed hogs to a heavier weight than would otherwise have been done. New developments, as the introduction of the tractor or the combine, may require an analysis of the manner in which this improvement can fit into the farm business.

Some of these adjustments may be of a permanent nature. The introduction of the tractor is an example of this type, but some of the adjustments may be temporary. The production program will return to normal as soon as the immediate emergency has passed.

Need for Careful Analysis. The adjustments in the production program must be analyzed as carefully as was the original organization. A change in one part of the farm business may seriously affect another part. A little time spent in careful consideration may make a big difference in the earnings obtained from the farm.

The analysis of the profitability of a change will be most accurate if all the estimates involved are listed in written form. If the proposed plan is complicated, it is frequently difficult to carry all the facts and estimates in mind. By recording all the data, the advantages and disadvantages can be more adequately weighed. If the proposed change does not appear profitable, it will be far better to have limited the error in judgment to errors on paper than to actually experience them in practice.

The written analysis of the proposed change should be preserved, if possible. The actual success that will be obtained from the plan can then be checked against the original plans. Such a check should enable the farmer to make more accurate estimates in the future. The data prepared at this time may be valuable for reference in the future, if similar problems arise.

Study the Changes. Study of the proposed adjustments in production will be simple if only the changes are estimated. It is not necessary to estimate all the receipts and expenses for the farm. The problem confronting the farmer is usually not that of determining earnings for the year, but rather that of determining whether or not the proposed change in some enterprise will increase or decrease the earnings, and by how much.

A simple and effective method of analysis can be illustrated by again utilizing data and problems relating to the Southeast Minnesota Dairy Farm. In Chapter III of *Agriculture II*, it was suggested that it might be profitable for this farmer to replace some of his horses with a moderate-sized tractor. Most of the horses are growing old and are approaching the end of effective service. Some of them will have to be replaced quite soon. But would a change to a tractor be advisable and profitable?

The Proposed Change. This farmer has kept about six work horses during the past years. He has raised a colt every two or three years to be used for replacement. Occasionally, after unusual death losses, he has purchased one or more horses. The machinery which is available on the farm has been listed in detail in Table I of Chapter II.

A two-plow general-purpose tractor equipped with rubber tires should provide ample power for the farm. A plow and corn cultivator will have to be purchased to fit the tractor. Other tractor equipment should probably be added, but these purchases can be delayed until funds are available. Although not as efficient, the horse equipment can be used temporarily. The number of horses should be reduced as much as possible in order to reduce to a minimum the investment in equipment and in the annual cost for power.

Detailed records which have been kept by this farmer during the past year make it possible to prepare an accurate analysis of the power needs of this farm. Although such records are not generally available, most farmers can make estimates which can be made to serve the purpose. Information which will be helpful for the analysis can be obtained from numerous books, experiment station bulletins, and other publications that are available.

Number of Horses Needed. The number of horses that will be needed can be determined by a careful analysis of the operations on the farm. The kinds and amount of work to be done and the time that will be needed are presented in Table XVI. In this Table are presented the hours of work under present conditions with horses supplying the principal power as contrasted with that which would be needed were a tractor used. If all possible operations are to be done with a tractor, only one team of horses will be needed. The principal operations for which the horses will be used are planting corn, helping with corn cultivating, hauling loads during threshing, silo filling, and shredding, and cutting and raking hay. The work for which the horses will be used is distributed sufficiently evenly throughout the year, so that not more than one team would be needed. Since most of the work done will be light, the amount of grain fed per horse can be reduced materially.

TABLE XVI—ANNUAL HOURS OF USE OF HORSES AND TRACTOR AND HOURS OF MAN LABOR TO DRIVE HORSES AND TRACTOR AT PRESENT AND AFTER PURCHASE OF TRACTOR[1]

Task	*Acres Covered**	*Hours of Use at Present*			*Hours of Use After Purchase of Tractor*		
		Man	*Horse*	*Tractor*	*Man*	*Horse*	*Tractor*
Care of livestock		65	130	...	65	130	...
General farm maintenance		112	224	...	88	176	20
Field work:							
Plowing	96	160	723	11‡	115	.....	115
Springtoothing	52	25	90	...	18	.....	18
Disking	57	30	118	...	19	.....	19
Spiketooth harrowing	383	115	339	...	46	.....	46
Planting corn	30	22	44	...	22	44	...
Cultivating corn	107	113	226	...	60	40	40
Cutting corn	30	43	119	...	60	.....	30
Filling silo	13	75	150	18‡	93	150	18
Shredding corn	17	141	282	30‡	171	282	30
Seeding grain	64	40	154	...	19	.....	19
Cutting grain	64	64	180	...	76	.....	38
Threshing	64	210	248	16‡	322	248	16
Cutting hay	40	46	92	...	46	92	...
Raking hay	54	29	58	...	29	58	...
Hauling hay		169	102	...	140	30	20
Hauling manure	299 loads		390	...	.....	50	40
Total		1,459	3,669	75‡	1,389	1,300	469

* Acres in the field multiplied by the number of times field is covered.
‡ Hired.

It is estimated that the tractor will be operated about 469 hours each year. There may be some time for odd jobs which should be added, but the number of hours will probably be small. On the basis of records obtained from other tractor farmers, this

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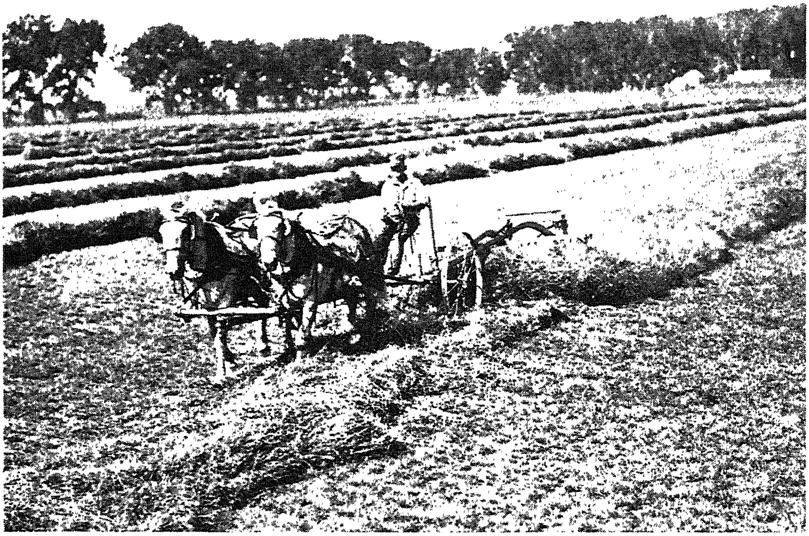
[1] Southeast Minnesota Dairy Farm.



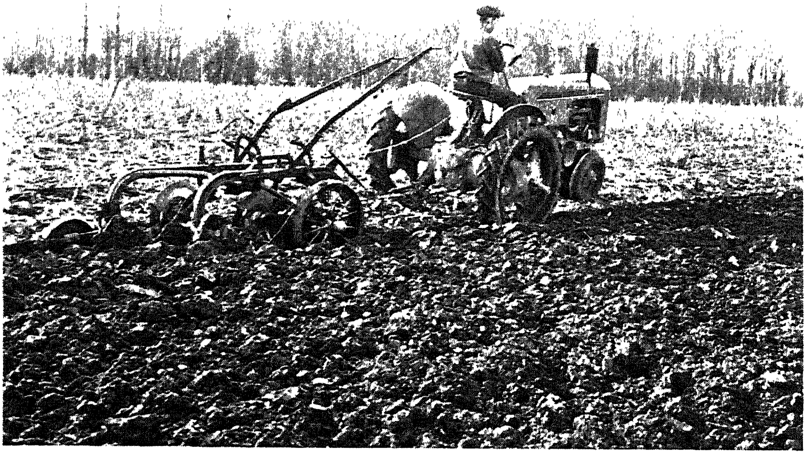


Figure 10. Above—Horses on side-delivery hayrake. Below—Tractor on two-bottom plow. A combination of horses for light work and a tractor for heavy work often gives efficient results on medium and large farms.

amount of use should require about 1,000 gallons of tractor fuel and 25 gallons of oil.

The number of hours of man labor required for the field work and other work requiring horses or tractor will not be reduced very much. The introduction of the tractor will, then, not make any material saving in labor. Even if the reduction in hours had been large on this farm, this change would not have been of any great importance since there already is insufficient work for the men.

Effect of Change on Cattle. According to this plan the number of work horses will be reduced from six to two. It will probably be more satisfactory to buy horses than to attempt to raise colts when only one team is kept. According to the records kept by this farmer, four horses and one colt use each year 11,000 pounds of grain, 11 tons of hay, and 2 acres of pasture. This quantity is enough to feed two dairy cows and the two extra heifers needed, and still leave approximately 265 bushels of oats (8,500 pounds of grain) to sell or to feed to other livestock. On this farm 1,100 pounds of grain, 3 tons of hay (or its equivalent in silage) and 1 acre of pasture are used per cow, and 100 pounds of grain, 1½ tons of hay and almost ½ acre of pasture for each head of young stock.

Change in Income and Expense. After determining all changes that will be made, the probable change in income, expense, and earnings can be determined. In estimating these changes, the prices used should be those which will be obtained when this plan is actually put into effect. Since it is frequently difficult to estimate future prices, the average prices obtained during a considerable period in the past may be used. The average price for several years will be more reliable than that received at the time the plan is being made.

The probable changes in the income and expense for this farm are summarized in Table XVII. The net value of the dairy products produced and of the change in the value of the herd has averaged $92 per cow during the past three years. One veal calf should be available for sale each year from these two cows. There will also be some additional oats to be sold or to be fed to other classes of livestock. The probable increase in income from the farm is estimated to be $288.75.

Breeding fees and part of the other costs for horses will now be eliminated. There will be no need for hiring a tractor in the future. These changes will save $115.50 in expense per year.

But there will be some new expenses to be paid. The horses must be replaced. For this farm it has been estimated that the horses would be used for about 12 years each. There will be veterinary and other costs to be paid for the two extra cows and the extra heifers. Tractor fuel, oil, and grease must be purchased.

TABLE XVII—Expected Changes in Income, Expense, and Earnings Resulting from Introduction of Tractor[1]

Item	*Price*	*Quantity*	*Value*	
Increase in income				
Value produced by cows.	$92 per cow	2 cows		$184.00
Veal calf	$12 per calf	1 calf		12.00
Oats	35c per bu.	265 bu.		92.75
Total increase in income				$288.75
Expenses decreased by				
Horse breeding fees	$25 per service	1 every 2 years	$ 12.50	
Other cash expense on horses	$4 per horse	5 horses	20.00	
Hire of tractor	$1.10 per hr.	75 hrs.	83.00	
Total decrease in expenses			$115.50	
Expenses increased by				
Replacement of horses	$100 per horse	1 every 6 years	$ 16.67	
Cash cost on cows	$2 per cow	2 cows	4.00	
Tractor fuel	9c per gal.	1000 gal.	90.00	
Oil	60c per gal.	25 gal.	15.00	
Grease			4.00	
Depreciation and repairs on tractor and extra machinery			95.00	
Total increase in expenses			$224.67	

Net increase in expenses $109.17

Increase in earnings from the farm $179.58

The cost of depreciation and repairs on the tractor and on the extra machinery must be included. It is estimated that a tractor will cost about $900 and will be worth about $200 at the end of 10 years, or a decrease of $70 per year. The investment in the plow and corn cultivator will probably be $150 more than at present. Estimating a life of 15 years for these items will give a depreciation of approximately $10 per year. Repairs will probably average around $15 per year. The probable increase in the expenses will then be $224.67.

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[1] Southeast Minnesota Dairy Farm.

Will the Change Be Profitable? On the basis of the above estimates, there will be a saving of $115.50 on some expenses, but there will be an increase of $224.67 in other expenses, or a net increase of $109.17. But the receipts will have increased $288.75, giving a net increase in earnings of $179.58.

In addition to these changes in income and expense, there will be other factors to be considered—factors which are more difficult to evaluate. With the tractor it may be possible that the work can be done more promptly and thoroughly than with horses, particularly when workdays must be long or when the weather is very hot. But the cash outlays will be larger. There will be a handicap in periods of depression when the prices of products sold generally decrease more than those of products purchased. An additional investment will be needed for the tractor and for machinery. The trading in of the surplus horses and old machinery will not cover the full purchase price. It is also probable that the cash on hand will not be sufficient to pay the difference. A small amount of money will have to be borrowed in order to pay for these items.

Taking all these factors into account, however, it seems that this will be a profitable change on this particular farm. The income will probably increase more than the expenses.

Although the purchase of a tractor appears to be profitable in this instance, it is not necessarily true that it will be equally profitable on other farms. Each farmer must make such a calculation as this in order to answer that question for his own situation.

Value of the Analysis. This analysis has provided some specific information for this individual farmer. He knows now more nearly what results he can expect from the change. Although the actual results may not be exactly as estimated, the decision which he makes will be more nearly correct than if this analysis had not been made. The decision would have been even more valuable if the farmer had considered other alternative methods of supplying power.

Although this discussion has centered around the purchase of a tractor, the same method can be used in analyzing other problems. A similar method can also be used to determine the profitability of a complete reorganization of the farm business.

Suggestive Questions

1. What reasons can you give that frequently require changes in the production program?
2. What are the advantages of a written analysis of proposed changes?
3. How many hours' work would there be for a tractor annually on your farm?
4. What work could be done with a tractor that can not be done by horses on your farm?

Suggestive Activities

1. Make a written estimate of the changes in the work load involved in substituting 20 acres of corn for 20 acres of wheat.
2. Determine what the net gain would be if the change were made.
3. Keep a record of the time spent on each crop raised on your farm, classified by operation.

CHAPTER V

SHAPING THE WORK PROGRAM

One of the big problems of the farmer is to so plan the work program that labor may be efficiently used. Labor generally ranks next to feed as a cost in livestock production. It ranks next to land and is approximately equal to power as a cost in crop production. Efficient use of such an item of cost must necessarily be an important factor in successful operation.

The farmers who are able to plan their organization and the details of their work in such a way that each worker can care for a large acreage of crops and a large number of livestock tend to obtain larger earnings than those whose labor accomplishment per man is less. This tendency is illustrated by the data presented in Table XVIII. The operator's labor earnings were only $700 for those farmers whose labor accomplishment per man was only 74 per cent or less of the average of this group of farmers; but they were $1,307 for those farmers whose labor accomplishment was 115 per cent or more. Similar results have been obtained from numerous other studies.

INFLUENCE OF FARM ORGANIZATION ON LABOR EFFICIENCY

The problem of securing efficient utilization of labor must begin with the organization of the farm. A wise combination of enterprises, a good physical layout of the farm, and a well-coordinated set of machinery and equipment will contribute materially to high labor efficiency. This problem must be kept in mind from the time that the first plans for the organization are laid. Constant attention must be paid to it in order to maintain an efficient organization.

IMPORTANCE OF A WELL-BALANCED CROP AND LIVESTOCK COMBINATION

The first step in planning an organization which will effectively utilize the labor is to provide a well-balanced crop and livestock combination. The crops grown must be those which will yield a high net return. The proportion of the land used for each crop must be such that the requirement for labor will be fairly uniformly distributed through the crop season. There should be no time when there are great peaks in the labor requirement, if it is difficult to obtain additional temporary labor.

The kinds of livestock raised, like the kinds of crops grown, should be those which yield the greatest return for the farmer. The kinds and numbers should be such as will equalize the labor load through the year. Work on livestock should be light when the work on crops is heavy.

TABLE XVIII—RELATIONSHIP OF OPERATOR'S LABOR EARNINGS TO LABOR EFFICIENCY[1]

*Labor Accomplishment**		*Number of Farms*	*Average Operator's Labor Earnings*
Range	*Average*		
74 and under	66	126	$ 700
75 to 94	86	528	859
95 to 114	103	483	1,153
115 and over	130	325	1,307

* Per cent of average of all farms.

Good crops on productive soil and good livestock will generally give the best returns to labor. No more work is required to seed high-yielding varieties of crops than to seed low-yielding varieties. Very little more labor and frequently less is required to raise crops on productive soil than on unproductive soil. The labor of preparing the seed bed and of seeding may be less on productive soil than on unproductive soil, although the labor of harvesting will generally be higher when the yields are high. Labor records kept by a group of farmers in Winona County, Minnesota, during the five-year period, 1935-1939, revealed a man-labor requirement of 3.4 hours per acre to prepare the seed bed and seed barley on farms where the yields were above average, as compared with 3.3 hours, or practically the same, on farms where the yields were below average. Harvesting, however, required 6.4 man hours per acre on the high-yielding farms compared with 4.8 on the low-yielding farms. But, in spite of the extra labor required for harvest, the total labor required to produce one bushel of barley was only .34 hour on the high-yielding farms compared with .45 on the low-yielding farms.[2] Similar relationships will be found to hold true for livestock.

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[1] Southeast Minnesota Farm Management Service, 1928-1937.

[2] (Unpublished data of the Division of Agricultural Economics, University of Minnesota.)

Productive and Unproductive Labor. Labor used in the care of crops and livestock may be defined as productive labor. Labor used in the repair and maintenance of buildings, fences, machinery, and equipment, in cutting weeds, and in tidying up around the farm may be defined as unproductive labor. The productive labor is that which results directly in products available for sale or for feeding. It is the income-producing work of the farm. The unproductive labor is that which does not yield directly any salable products and does not add to the income. Although much of it is necessary, this work is primarily a source of expense. The farm should be so organized that as large a proportion of labor as possible can be spent in productive work.

Figure 11. Harvesting sugar beets in the Red River Valley. Land is used intensively in producing sugar beets, resulting in a relatively high income per acre. Labor used in growing sugar beets is, therefore, productive labor.

Some unproductive work is, nevertheless, necessary on all farms. Buildings and fences are necessary for livestock production. Machinery is needed for crop production. It must be kept in repair to prevent too rapid deterioration and to avoid serious cash outlays at a later date. Weeds must be cut and ditches must be filled to maintain the productivity of the soil.

Some work, as keeping the farm neat and orderly, may be justified on the basis of the pleasure derived by the farmer and his family even though it yields no financial return. But the farmer must carefully determine whether or not this work will yield greater satisfaction than the things which could be purchased if the work were devoted to tasks increasing the income. Will this satisfaction be of more value than the additional comforts that could be purchased for the home, or the education that could be provided for the children?

Wise Use of Family Labor. The organization of the farm must provide ample productive work for the family labor. Since no extra outlay is needed for this family labor, it is frequently used very freely, particularly on unproductive work. But, if ample productive work were available, the earnings of the farm could be increased and the standard of living raised.

Less productive work generally can be provided for family labor than for a corresponding amount of hired labor. Since part of the responsibility of the parent is to teach the children, considerable time must be spent in giving this instruction. The children must be given an opportunity to perform many tasks which are new to them; but one of the valuable lessons which must be taught is, that the successful man spends a large proportion of his time in effective application to productive tasks.

Efficient Farm Layouts Are Necessary. The physical layout of the farm must be carefully planned in order to promote labor efficiency. Fields must be of good shape and sufficiently large to waste little time in turning or in moving from one field to another. According to labor records kept by a group of farmers in Winona County, Minnesota, the labor requirements per acre for crop operations are smaller in large fields than in small fields. The data obtained from these records are summarized in Table XIX. Labor requirements for harrowing and for drilling small grains were quite high for fields of less than 5 acres. They were considerably smaller for fields of 5 to 10 acres. The increase in labor efficiency was quite small for fields of more than 15 acres. In areas where larger machines are used, the most efficient size of field is probably larger than this. The fields must also be so arranged that the distance from the farmstead to the field is short.

The farmstead must be equally well planned. Placing the buildings close together, but leaving enough space for adequate fire protection, will save many steps and much time. Placing the granary near the barn and the corncrib near the hog house will eliminate much unnecessary work in carrying feed. The machine shed should be located between the barn and the fields. Fences around the farmstead should be few, in order to save outlay for construction and labor for maintenance, and they should be so located in relation to the buildings and fields that it will rarely be necessary for the farmer to open and close gates in going about his day's work.

Each building should be planned to save time and labor. Hay and grain-storing equipment should be adapted to the building. Hay chutes and grain spouts should be located near the mangers. The milk house should be near the barn to provide quick access to the milking equipment. The numerous available bulletins and books on farm construction will provide many other suggestions for labor-saving plans and devices for the farm buildings.

TABLE XIX—MAN HOURS REQUIRED PER ACRE FOR HARROWING AND DRILLING SMALL GRAIN WITH HORSES ON FIELDS OF VARIOUS SIZES[1]

Size of Field	*Man Hours Per Acre*	
	Harrowing	*Drilling Small Grain*
0.0 to 4.9 acres	.46	.93
5.0 to 9.9 acres	.36	.71
10.0 to 14.9 acres	.31	.62
15.0 to 19.9 acres	.27	.60
20.0 to 24.9 acres	.27	.62
25.0 acres or more	.24	.57

The power and machinery should be adapted to the farm and to the labor supply. The type and size of the machinery should be adapted to the source of power. Insofar as possible tractor machinery should be used with the tractor. Power and labor are frequently wasted when horse equipment is used with the tractor. The large amount of machinery which is used on a modern farm seriously complicates the problem of co-ordinating machines and power. Many machines must be used after improvements have been made on others. Many farmers are still using machinery designed for the standard narrow-tread tractor after they have purchased a general-purpose row-crop tractor. Careful thought and planning for many future years will help them to select the machinery which is best adapted to their situations.

Size of Farm Affects Labor Efficiency. The size of the farm is one of the important factors influencing efficiency in the use of labor. The size of fields can be large on large farms, and large labor-saving machines can be used. For many tasks in the care of livestock, little more time is required for a large herd than for a few head. Labor accomplishments tend to be higher on large than on small farms. Among the southeast Minnesota dairy farmers that have been referred to several times previously, the labor accomplishment per man was only 88 per cent of the average on farms of less than 140 acres, but was 111 per cent on farms of 240 acres or more.

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[1] Winona County, Minnesota, 1935-1936.
(Unpublished data of the Division of Agricultural Economics, University of Minnesota.)

The size of the farm, however, can not be increased indefinitely in the effort to increase the efficiency of labor utilization. After a moderate-sized farm has been provided, the labor saved by a further increase in size will be quite small. Although labor efficiency can be increased by the use of large machines, the increase will be small, if the farm becomes so large that a second machine must be added. Problems of supervision are also increased with the increase in size of the farm. This problem is very serious for many farmers. Many men are able to plan their own work very effectively, but can not plan work for others. Some men are unable to judge and select capable hired men and to handle them in such a manner as to obtain the most productive work.

INFLUENCE OF WELL-PLANNED OPERATION ON LABOR EFFICIENCY

Good management of labor must accompany a good organization in order to achieve high labor efficiency. All tasks planned must be completed. Tasks which are of a seasonal nature must be performed at the time which is most favorable. The tasks which will be performed each day must be those which are most important. The worker assigned to each task must be the one who can perform the task most economically.

The Calendar of Work. The work must be planned for a considerable time into the future in order that time may be available for each task and that power and equipment may be provided for each worker when he needs them. Although many farmers are able to carry in their minds the large number of details which are involved in the operation of a farm, most men must use some supplementary aid in their planning. A carefully prepared calendar of operations will help the farmer to anticipate the tasks which lie ahead and plan for their performance. A brief calendar of work for the southeast Minnesota dairy farmer is presented in Table XX. Only the major tasks are listed. The data for this calendar were obtained from the farmer's records. There are several other forms of calendars that could be used.

The first step in the preparation of a calendar of work is to make a list of all the tasks to be performed. These should be grouped according to the enterprises to which they pertain. For example, the tasks involved in the production of corn may be plowing, disking or springtoothing, harrowing, planting, cultivating, and harvesting. This list will vary among the farmers according to the crops grown and the type of soil and equipment available. Particular care should be taken to list all tasks which do not constitute part of the day-to-day chore work.

After preparing the list of tasks, the next step is to determine the time when each must be performed. The experience of the farmer will generally provide the information which is needed. Records kept by him will help to make these dates more definite. Many farmers keep records of the dates when they begin their principal operations, as their grain seeding. Data obtained from research work and published by experiment stations and information given by neighbors will provide valuable help to the inexperienced farmer.

The experienced farmer will know the approximate amount of labor which will be needed for each enterprise and will know the periods when the different tasks will conflict for labor. The inexperienced farmer or the farmer reorganizing his business must estimate the time required for each task. Here, too, the experiences of the farmer and the information gained from neighbors will provide much of the necessary data. Many experiment stations have issued publications giving the average labor requirements for various tasks. The length of time required each month on the Southeast Minnesota Dairy Farm is shown in Table XX. Variations in the labor required for the regular chore work should be carefully noted.

The calendar of work will indicate the times of year when there is likely to be an extremely heavy demand for labor. The work on the Southeast Minnesota Dairy Farm seems to be fairly well distributed. A slightly larger proportion of this work could have been planned for June, July, and August when the children are not in school. The general repair work has been planned for the months when crop work is light. For example, the fence on the west side of field No. 4 had to be repaired before the cows could be turned out. This work was planned for May, when crop work is light. It should have been done the previous fall.

The calendar of work will also serve as a valuable reminder of tasks to be done. Each task should be checked off when it is completed. New ones which arise should be added.

Effect of the Wage Level. The tasks which will be completed during the year and the thoroughness with which they will be performed will depend partially upon the wage level. When

TABLE XX—Calendar of Work[1]

Task to Be Performed	Approximate Starting Date	Approximate Man Hours Required											
		Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Small grains—													
Clean seed	March	......	......	55	......	......	......	......	......	......	......	......	......
Springtoothing	Apr. 10	......	......	......	12	......	......	......	......	......	......	......	......
Harrowing	Apr. 10	......	......	......	52	......	......	......	......	......	......	......	......
Seeding	Apr. 14	......	......	......	39	......	......	......	......	......	......	......	......
Cutting and shocking	July 20	......	......	......	......	......	......	300	......	......	......	......	......
Threshing	Aug. 5	......	......	......	......	......	......	......	210	......	......	......	......
Corn—													
Spring plowing	May 5	......	......	......	......	30	......	......	......	......	......	......	......
Harrowing	May 10	......	......	......	......	40	......	......	......	......	......	......	......
Planting	May 15	......	......	......	......	22	......	......	......	......	......	......	......
Rotary hoeing	May 30	......	......	......	......	16	......	......	......	......	......	......	......
Cultivating	June 5	......	......	......	......	......	88	25	......	......	......	......	......
Cutting	Sept. 1	......	......	......	......	......	......	......	......	42	......	......	......
Filling silo	Sept. 4	......	......	......	......	......	......	......	......	120	......	......	......
Shocking	Sept. 20	......	......	......	......	......	......	......	......	82	......	......	......
Shredding	Oct. 10	......	......	......	......	......	......	......	......	......	200	......	......
Hay—													
Phalaris—1st cutting	June 10	......	......	......	......	......	42	......	......	......	......	......	......
2nd cutting	Sept. 1	......	......	......	......	......	......	......	......	33	......	......	......
Alfalfa } —1st cutting	June 15	......	......	......	......	......	90	14	......	......	......	......	......
Timothy } —2nd cutting	Aug. 20	......	......	......	......	......	......	......	68	......	......	......	......
Miscellaneous crop work—													
Planting potatoes	May 25	......	......	......	......	20	......	......	......	......	......	......	......
Digging potatoes	Sept. 25	......	......	......	......	......	......	......	......	32	......	......	......
Fall plowing	Aug. 25	......	......	......	......	......	......	......	28	......	60	78	......
Manure hauling	......	41	......	18	102	22	......	......	......	......	70	......	......
Total crops	......	41	......	73	205	150	220	339	306	309	330	78	......
Work on wood	Fall & winter	......	......	......	......	......	......	......	......	......	......	120	120
Rebuilding fence west side of field 4	May	......	......	......	......	50	......	......	......	......	......	......	......
Repair fence, especially around field 10	Aug.	......	......	......	......	......	......	......	30	......	......	......	......
Repair hayloft	June	......	......	......	......	......	100	......	......	......	......	......	......
Prepare building for winter	Nov.	......	......	......	......	......	......	......	......	......	......	100	......
Repair harness and machinery	Feb. & March	......	40	60	......	......	......	......	......	......	......	......	......
Livestock	......	500	540	600	510	470	420	460	370	380	380	400	480
TOTAL LABOR REQUIRED	......	540	580	733	715	670	740	799	706	689	710	698	600

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[1] Southeast Minnesota Dairy Farm.

wages are high, some tasks may be omitted and others may be done less thoroughly in order to save time. Slightly lower yields may be accepted in order to reduce the labor costs. Much of the work of repairing of fences and of buildings, cutting of weeds, and other maintenance work may be omitted or postponed. The farmer must determine whether the extra work done will yield a return sufficiently high to pay for the extra labor cost.

Assign Each Worker to the Right Job. The farm manager can well spend time in studying the abilities and preferences of each worker. Each man can then be assigned to the task for which he is best fitted. For example, the man who is most proficient at handling a tractor should do most of the work involving the use of the tractor, while the man whose interest lies in horses should be assigned to the work which utilizes the horses. Each man will then do the job in which he is most efficient. By doing this type of work throughout the year, he can acquire the skill which will increase his efficiency.

On farms where a large amount of family labor is available, this type of assignment of tasks will not be as well adapted. In order that the children may learn the problems of farming as thoroughly as possible, each one must be allowed to perform a variety of tasks even though he may not be as efficient at some work as some of the other children. The training will probably be more thorough, however, if they are allowed to remain at each task sufficiently long to acquire some skill.

Planning the Details of the Day's Work. The calendar of work will provide a general guide as to the tasks that are to be performed during the year, but the work for each individual day must be planned in considerably greater detail than is provided by this calendar of work. The tasks to be performed during the day must be arranged in the order which will give the least waste of motion. Jobs of a like nature should, insofar as possible, be performed at the same time of the day. For example, if one day a certain worker is to haul out a load of manure from the barn, finish planting the corn, repair a fence, and hoe the garden, the jobs requiring the use of the horses should be done in succession in order that time will not be wasted in hitching and unhitching the horses.

The successful farm manager will plan his work far enough ahead so that all arrangements are made for each task when the time comes. For example, if the job for a particular day is to spray the potatoes, the spray materials should be on hand and the sprayer should be in condition by that day. If the farmer has planned ahead, he will have purchased the spray materials while in town on some other errand and the equipment will have been repaired, oiled, and adjusted on some rainy day. Many farmers waste much time going to town on errands that could have been avoided had they been more foresighted.

The farm manager must plan alternative tasks for each day. If he had planned to work in the fields on a certain day, a shower might upset those plans and require the assignment of different tasks. A notebook carried in the pocket or a sheet tacked in the barn may be used to keep a record of tasks that are to be performed on rainy days. Tags attached to the machines at the time they are stored, indicating repairs that must be made, will also be helpful to provide suggestions for work on rainy days.

Labor efficiency may also be increased greatly by utilizing short periods of time that are easily wasted. A few minutes between the time that one task is completed and the time to quit work for noon or for the evening may be profitably spent in doing some of the many small jobs around the farm. For example, one farmer completed the work of repairing his fences at about 11:30 in the forenoon. Since he was planning to cultivate corn in the afternoon, he harnessed the horses and greased the corn cultivator during the time that he was waiting for dinner. He was then ready to put in a full afternoon's work in the cornfield.

Timeliness of work is frequently a factor increasing the efficiency of labor. If the corn is cultivated at the proper time when the weeds are just breaking through the ground, when most of the weed seeds have germinated and the plants are too weak to withstand the disturbance of the cultivator, fewer cultivations may be necessary.

The Human Element in Labor Management. The wise farm manager realizes that after all the problem of labor efficiency is to a large extent a human problem. Even though the farm is well organized and the work is well planned, labor accomplishments will not be high unless each worker exerts himself in order to work as rapidly as possible. Each worker's full attention must be applied to the task at hand.

Each worker on the farm should be encouraged to take an interest in his work. Although the workers should be reprimanded for careless work or should be corrected on work which is not properly done, they should also be commended for work which is well done. A worker will generally take a greater interest in the work and work more efficiently if he carries some of the responsibility for the performance of the task. This responsibility can, of course, be assigned to him only insofar as he has demonstrated his ability to carry it.

The farmer must always be alert to find new ways of improving his efficiency. He must observe the methods that are used by other farmers. He must be particularly careful not to assume that the methods which he carefully planned a number of years ago can not be improved today.

Suggestive Questions

1. What is meant by productive work?
2. In what ways can unproductive labor be justified on a farm?
3. Define family labor.
4. How can the labor requirements be reduced on your farm?
5. In what ways does size of farm affect labor efficiency?

Suggestive Activities

1. Make up a daily routine schedule for the work on your project farm, assigning each worker to his daily task.
2. Make up a rainy day schedule of jobs to be done on your project farm.
3. Keep a record of the hours worked each day by each worker on each kind of work done for a month.
4. Compare the records made with those made by other students and determine the labor efficiency for each farm.

CHAPTER VI

EQUIPMENT FOR ECONOMIC OPERATION

The equipment of a farm begins with buildings to house the operator and his family, to shelter his animals, and to store the products of the farm. It continues in the provision of power and implements for tilling the land, in processing crops, and in providing foundation herds of productive livestock to round out the production program. It is completed by the provision of convenience or ease-giving equipment. Those with limited funds are wise to be conservative in their investments in the latter group until production is established and income assured. The individual operator must study these problems as related to the farm under operation. He should erect buildings, provide power, and buy machinery only as it can be shown that the income from the farm will be increased, that the labor of himself and family will be decreased, or that the comforts and satisfactions of the home will be greater than before. There is no argument against buying equipment to ease or reduce the labor load on farms not under financial stress or where income is large enough to permit the expenditure without limiting funds for other demands.

BUILDINGS IN RELATION TO THE FARM

In the long run the land must support the buildings. The wealth comes from the land. Few buildings return a direct profit on the money invested in them. On the contrary, as soon as erected they begin to depreciate. There is expense annually for upkeep and maintenance, and this expense must be met by income from the farm. That there is a close relation between the land and the buildings can be demonstrated in almost any county in the United States. A survey of the farms, township by township, will show that the best buildings, as a rule, are to be found on the best land. The farms on which the buildings are poor will be found on examination to have land of poor quality. It is difficult indeed to pay for high-cost buildings from the earnings of farms established on poor soil. One setting out to equip a farm with buildings should consider not only the funds immediately available but the probability of annual and long-time income. The cost should be within the earning power of the land.

The Farmhouse. How good a house should a farm family have? The correct answer to that question is: *The best the farm can afford and support.* A good house undoubtedly adds to the value of a farm as a home and increases its selling value. It does not, however, add in any way to production or income from the farm. It is more likely to be a bill of expense. The depreciation and upkeep annually will amount to 3 to 5 per cent or more on the investment. Insurance should be carried, which is an additional expense. The operator must have a house for his family to live in, but it is not a productive factor in the farm business. In providing a farmhouse, the desire for comfort and the personal satisfaction of living in a good home must be weighed against the possibilities of paying for it and supporting it from the earnings of the farm on which it is located. It is better to begin with a modest and reasonably-priced house and to improve or replace it when earnings will permit than to overbuild and incur the danger of financial embarrassment. On the average farms of the United States an investment of $1,000 to $3,000 for a farmhouse is as much as should be charged against the farm unit. Some farmhouses are valued higher than the figures given above, but

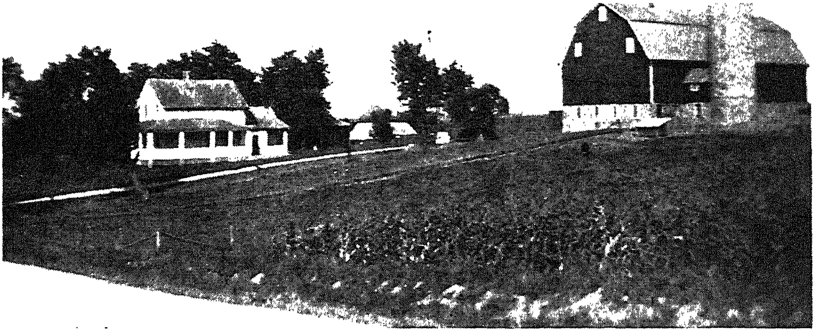

Figure 12. Farm houses and barns should be proportioned to the size and needs of the family and the farm business. Needless or unused buildings are an expense burden to the farmer.

they contribute no more to the farm income than more modest homes. A part of the cost of such houses should be considered as a personal expense of the operator.

Barns and Outbuildings. Barns and outbuildings, like houses, are provided and maintained at an annual expense for upkeep, repairs, and insurance. To meet that expense they must shelter productive livestock, protect feed supplies, and prevent deterioration of machines, implements, and other equipment. The returns from such buildings are indirect and not easily determined; yet the buildings are indispensable. Buildings on farms in the northern dairy and hog region are much more numerous and expensive than those on farms of the South or of the Great Plains wheat or range regions. They are also more necessary. Warm barns and comfortable stalls are required in the North where winter dairying is widely practiced. To be warm and comfortable, barns need not be unduly expensive. It is far more important that they be well planned, and fully occupied than that they be large and pretentious in appearance. Comfort for the animals housed, and convenience in storing feed supplies are the first consideration. Of equal importance is the matter of labor saving in the daily care of the animals housed. While such matters originate in the organization of a farm, they must be considered frequently by the farm operator in planning his work program. It often is good economy to relocate a building or rearrange the interior of one to lessen the labor required in doing the daily chores.

Granaries, corncribs, and other feed-storage buildings should be placed conveniently near where the feed is to be used. One must remember that, to appreciate the value of well-placed feed supplies, feeding must be done two or three times a day every day in the year. The same arguments apply in the placing of a machine shed, garage, or workshop. These buildings need not be expensive, but they should be well placed and well planned.

Most important of all is a good water supply with water accessible at will to all classes of livestock and to the household. Attention has been frequently called to the need for water, by both plants and animals, in promoting the normal bodily functions required for growth and production. Stock that must be taken to water or have water carried to it is almost sure to be undersupplied. Less labor is required if water tanks can be provided at convenient places in barns, yards, and pastures where the animals can drink when the desire for water is felt. Farm records show, too, that the best gains and production are obtained when livestock has free access to water. On most farms access to water can be given by well-arranged yards suitably fenced, with troughs or tanks at convenient points. A few dollars spent for fencing, tanks, and piping will not only save labor but often increase the income from livestock.

FARM POWER

In considering the matter of power and machine use one must keep in mind the primary purpose or objective. It is to enable the operator to minimize the amount of man labor required to operate the farm. Power would be of little value except it be used to drive machines or implements that reduce the amount of labor done by hand. Machines are, in fact, substitutes for human labor in doing the farm work.

The kind of power to be used on a farm properly should be determined when the organization plans are made for the farm. The farm operator must always be alert, however, to changing customs and the wisdom of changing as progress is made. Three forms of power are in use on American farms. These are (1) animal, (2) internal combustion engine, (3) electric. Of these, animal power is most widely and universally used, though rapidly being displaced by tractors. Electric power is also gaining favor rapidly for belt work, but is not yet adapted to field work requiring portable power. It is not uncommon to find two of these forms of power used on diversified farms. On many well-equipped, large farms with a diversified production program all three forms may be used to advantage. The form or combination of forms of power to use can be determined only by a knowledge of the power demands for a given farm. A discussion of the characteristics of each form may be helpful in meeting the problem.

Animal Power. Farming is a business where the turnover of capital is slow. It is a business, therefore, that is not well adapted to large cash costs.

One of the advantages of horse power is its low cash outlay. The farm work may well be done by brood mares capable of producing their own replacements. They may be kept almost entirely on farm-grown feeds, and cash outlay may be thus avoided. Horse power may be used in adaptable units of one, two or three, to twenty horses, depending on the load to be moved or the work to be done. It is true that large teams of horses require more time for their daily care than tractors; but, again, this is not an out-of-pocket cash cost. The operator who has plenty of land and family labor and who is limited in cash for operating should seriously consider continuing to use horse power for his field operations. This power is particularly advisable where machines and implements are made for horses, and a change in power would involve a new line of machinery. The problem must be considered from the long-time point of view and a changeover, if contemplated, should be made gradually as it can be afforded.

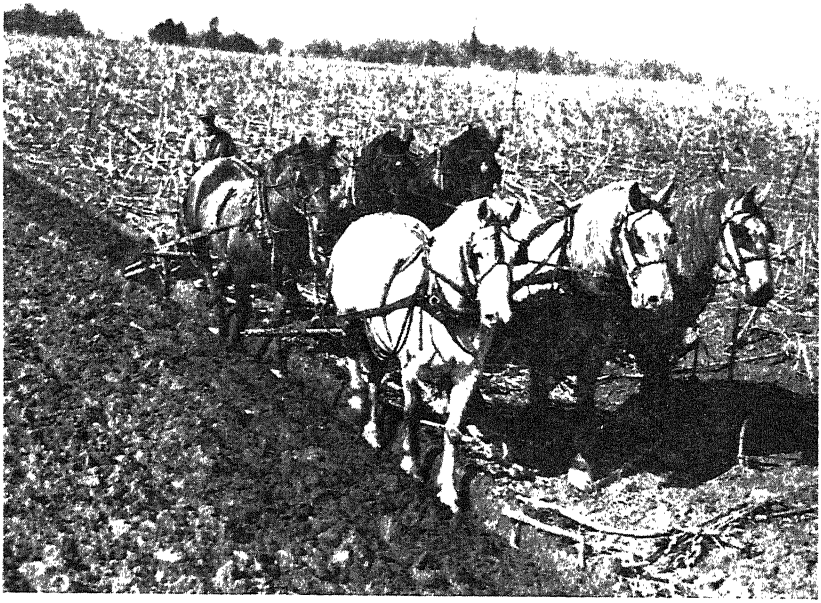

Figure 13. Man labor is economized by using horses in large teams on well-proportioned work loads.

Tractor Power. Farm tractors are increasing rapidly in numbers and adaptability. This fact must be construed to mean that farmers are finding them satisfactory as sources of power. Some of the reasons for their advantage are plainly seen. A tractor can serve in the field more hours a day than is physically possible for horses. By changing operators it can be used 12 to 18 or even for 24 hours a day. With suitable equipment, a higher rate of travel is possible and an operator can accomplish much more in the same number of hours than he can with horses. The ability to get the work done when the weather and the season are favorable accounts largely for the rapid substitution of tractors for horses as a source of farm power. That the tractor requires neither fuel nor care when not at work is another point of advantage in gaining popular favor.

Against these advantages must be weighed the heavy initial cash cost of the tractor, the cash cost for replacement, the cash expense for fuel, oil, and repairs, and the difficulty of adapting the available tractor power to the kind and size of the work load to be done. Skill and mechanical ability are essential qualities in the satisfactory and efficient use of a tractor. It is important also that the tractor be of a type adapted to the size of farm operated and to the kind of work to be done.

Relative Cost. Many studies have been made of the comparative costs of horse and tractor power. The cost per hour for each is quite generally shown to depend upon the number of hours of work performed during the year. Since the overhead expense for providing and maintaining power are nearly constant in either case, it naturally follows that the more hours of service given, the lower the cost per hour for the service. While there is a wide variation in the cost per hour of animal power from farm to farm, averages reported for groups of farms where records have been kept usually range from 15 to 20 cents for horse work. A two-horse team at ordinary farm work would, therefore, be figured at 30 to 40 cents an hour unless records for the individual farm show the cost to be more or less than the figure indicated.

Tractor costs per hour are somewhat more difficult to determine because of the wide variation in tractor types and in the work performed. The annual cost of maintaining a tractor capable of pulling a two-bottom plow will range from $200 to $400. The annual cost of maintaining a tractor capable of pulling a two or three-bottom plow varies widely, ranging from 45 to 50 cents an hour to 80 or 90 cents depending in large measure on the efficiency of the operator, the number of hours used annually, and the price of fuel and oil.

To pull a two-bottom plow comfortably through the plowing season would require five horses. Figured at the low cost of 15 cents an hour, the cost for horse work would be 75 cents which is approximately the average cost per hour for tractor power. Since a tractor travels at a faster pace than horses, more land will be plowed in a day. An acre per day per horse is the usually expected result from a horse-drawn plow. A tractor-drawn plow of the same size will turn 7½ acres per day. The power cost per acre with the horse-drawn plow would be $1.50 as compared to $1.00 for the tractor-drawn plow. Before deciding that a tractor should be used, one must consider the greater cash cost involved in its use and the work other than plowing that can be done with it on the farm under consideration. In doing light work requiring only one or two-horse power with a heavy tractor costing 80-90 cents an hour to operate, the expense for power would be much higher than if horses were used.

Electric Power. The use of electricity on farms is rapidly increasing. Up to the present time its use is limited almost entirely to belt work and the operation of convenience equipment designed to lighten the labor of the family in doing the routine chore work of the household and farm. Its most universal use is for lighting the farm buildings. On many farms where heavy field work requiring much power is limited, a combination of animal power for field work with electricity for belt work and household use may be more economical than tractor power. No fixed rule can be laid down for making such combinations, but farm operators should figure carefully on the relative merits and costs of each form of power available to them.

MACHINERY AND IMPLEMENTS

There is almost no end to the supply of machines, implements, and tools devised to be useful in the operation of a farm. Which ones should the operator buy? How can he decide which is within his means to buy and be most useful in doing the farm work? The answers to these questions and to many others that will come up lie in the nature and amount of work there is to do. How much tillable land is there? How much of it must be plowed annually? How many acres of grain will there be to harvest? Of corn to be harvested? Of hay to be cut? And thus through the list. Perhaps it would be cheaper to hire a neighbor to cut the grain than to buy a machine. These are all problems that must be solved for each individual farm. There is no direct solution for them, but there are principles of economy that will help, if used, in finding the right solution.

Maximum Use Important. Attention has already been called to the importance of getting a large amount of work from each unit of power (horse or tractor) in reducing the cost of power. It is equally important that each machine or implement be fully employed on productive work, if income is to be made on its use. The first matter to consider is the kind and amount of work to be done. For example, on my 320-acre farm how many acres of grain are there to harvest each year? How many acres a day will the contemplated machine harvest? What is the length of the harvest season? Let us assume that there are 200 acres of small grain to harvest annually. With tractor power and a seven-foot, self-binding harvester drawn at 3 miles per hour, 18 acres per 10-hour day can be cut. Not allowing for breakdowns or delays, approximately 12 days will be required to harvest the crop. The length of the harvest season is determined by the condition of the crop. To be at its best in yield and quality, grain should be harvested just at maturity. If harvested too early, there is loss in yield. If harvest is delayed much past maturity, there is likely

Figure 14. Power and implements replace man labor in such operations as shown above.

to be loss in quality from bleaching or coloring. There is danger also of loss from hail or heavy rains. Part of the grain crop is barley, part early oats, and the balance, 120 acres, is spring wheat. These grains ripen in succession and all can be harvested with the machine contemplated. The machine could well be used for a greater number of days, but there is no more work for it to do. Twelve days is more than most binders are used, so that costs for ownership and daily use are relatively low. Davidson, of Iowa State College, gives $32.62 as the annual cost for ownership of a self-binding grain harvester.[1] This cost, spread over the 200 acres of grain harvested, makes the cost per acre for binder use 16.3 cents. The same annual cost would be met if only 100 acres were cut, but the cost for binder use per acre would be doubled, or 32.6 cents. The same method of calculating would apply to all machines or implements used in growing the grain crops. Obviously, the cost of producing grain would be reduced by getting the maximum seasonal use from each machine.

Few machines are used to their full capacity either in the number of days operated annually or in the amount of work done daily. The efficiency or capacity of a machine is based on the speed at which it is driven and the steadiness of operation. The use of the machine on most farms is interrupted by the demands on the time of the farmer for chore work and emergencies which frequently arise. Insufficient or poorly-adapted power for driving the machine may reduce its efficiency also. These are all matters that lie within the ability of the operator to correct.

Determining Cost for Machine Use. Few farm operators recognize fully the costs that must be met in providing machinery for operating. A study of the annual cost for maintaining each machine of major importance will be helpful in determining whether or not it is wise to buy. The first step in such a study is to consider the factors of cost in maintaining a machine. These may be listed as (1) depreciation, (2) interest on investment, (3) repairs, (4) housing, (5) miscellaneous. A sample formula for determining each of these annual costs is given below.[2]

1. $\text{Depreciation} = \dfrac{\text{First cost}}{\text{Estimated life in years}}$

2. $\text{Interest} = \dfrac{\text{First cost} + \text{annual depreciation} \times \text{rate}}{2}$

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[1] *Bulletin 260,* Iowa Agricultural Experiment Station.

[2] Unpublished formula from Division of Agricultural Engineering, Minnesota Agricultural Experiment Station.

3. Repairs = Estimated percentage of first cost or annual records and experience.
4. Housing = Cost per unit of space occupied @ estimated rate[1].
5. Miscellaneous—any other cost not included above.

The use of this formula is illustrated in the following example of the cost of using a grain drill.

Assume: 20 x 6 drill, first cost $220.00, life 18 years, rate of interest 6 per cent, annual acreage 90, acres per day 15.

1. Depreciation $= \frac{220}{18}$	=	$12.22
2. Interest $= \frac{220 + 12.22 \times .06}{2}$	=	6.97
3. Repairs = 0.5 per cent of first cost....................	=	1.10
4. Housing = 12′ × 6′ × .02...............................	=	1.44
Total annual cost..............................	=	21.73
Cost per acre $= \frac{21.73}{90}$	=	.24
Cost per day = .24 × 15............	=	3.60

The same formula can be used for determining in like manner the annual cost and the cost per day or per acre for any other machine. It may be used also in determining the fixed costs for the use of a tractor. To the fixed costs for the tractor the costs for fuel and oil and other lubricant must be added. The costs for these items must be determined from experience or, better yet, from records of amounts actually used.

A formula is included here also for determining machine capacity per hour in acres. It is governed by the width of the machine and the speed at which it is driven.[2] This formula will be useful to ascertain the expectancy for any proposed machine use and in deciding what size to buy.

Machine Capacity—

$$\text{Acres per hour (theoretical)} = \frac{S.\,W.\,5280}{43560}$$

S = speed in miles per hour
W = working width of machine in feet
Assume 17.5 per cent time lost in turning.

$$\text{Then acres per hour} = \frac{S.\,W.\,5280 \times 82.5}{43560 \times 100} = \frac{SW}{10}$$

$$\text{Acres per 10-hour day} = \frac{SW}{10} \times 10 = SW$$

This formula shows the normal working capacity of a machine in acres for a 10-hour day to be equal to the width in feet multiplied by the speed in miles per hour.

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[1] The rate per square foot of space occupied is often figured on the basis of 10 per cent of first cost of shelter. A machine shed 20 x 50 costing $200.00, or an annual cost of $20.00, would provide floor space at 2 cents per square foot.

[2] Division of Agricultural Engineering, Minnesota Agricultural Experiment Station.

TABLE XXI—Total Cost of Service, Depreciation, Interest and Repairs, Annual Cost and Cost Per Day of Use[1]

Machine	*Basic or Average Retail Price Dollars*	*Average Life in Years*	*Annual Depreciation and 7 Per Cent Interest*		*Annual Cost of Repairs*		*Annual Cost of Housing and Insurance*		*Total Annual Cost*		*Average Annual Service Days*	*Cost of Service Per Day $........*
			Pct.	$	Pct.	$	Pct.	$	Pct.	$		
Corn binder	230	14	11.43	26.22	1	2.30	2	4.60	14.4	33.19	6	5.53
Corn picker	400	10	14.2	56.96	1	4.00	2	8.00	17.2	68.96	15	4.60
Corn planter	80	15	11.0	8.78	1	0.80	2	1.60	13.98	11.18	6	1.86
Corn sheller, 1-hole	13.50	18	9.9	1.35	1	0.14	2	0.27	12.9	1.64	12	0.14
Corn sheller, 2-hole	215	18	9.9	21.37	1	2.15	2	4.30	12.9	27.82	12	2.32
Cultivator—												
1-horse	9	15	11.0	0.99	5	0.45	2	0.18	18.0	1.62	17	0.10
1-row	56	15	11.0	6.15	5	2.80	2	1.12	18.0	10.07	20	0.50
2-row	115	15	11.0	12.63	3	3.45	2	2.30	16.0	18.38	16	1.15
Ensilage cutter	350	10	14.2	49.70	1.5	5.25	2	7.00	17.5	61.05	7	8.72
Feed grinder	37	15	11.0	4.06	1.5	0.56	2	0.74	14.5	5.36	18	0.30
Gas engine, 2-hp	60	15	11.0	6.59	1	0.60	2	1.20	14.0	8.39	80	0.15
Grain binder	240	16	10.6	25.42	1	2.40	2	4.80	13.6	32.62	6	5.41
Grain drill	175	18	9.9	17.40	.5	0.88	2	3.50	12.4	21.78	6	3.63
Harrow—												
Disk	65	15	11.0	7.14	2	1.30	2	1.30	15.0	9.74	13	0.75
Smoothing	40	20	9.4	3.78	1.5	0.60	2	0.80	12.9	5.18	11	0.47
Spring-tooth	50	8	16.8	8.38	.5	0.25	2	1.00	19.3	9.63	10	0.96
Hay loader	135	20	9.4	12.59	1	1.35	2	2.70	12.4	16.74	8	2.09
Hay rake—												
Dump	50	20	9.4	4.72	1	0.50	2	1.00	12.4	6.22	6	1.04
Side delivery	110	16	10.6	11.65	1	1.10	2	2.20	13.6	14.95	6	2.48
Sweep	65	14	11.4	7.43	1	0.65	2	1.30	14.4	9.38	6	1.56
Hay stacker, swinging	120	14	11.4	13.72	1	1.20	2	2.40	14.4	17.32	6	2.90
Manure spreader	160	14	11.4	18.29	1.5	2.40	2	3.20	14.9	23.89	25	0.96
Mower	80	15	11.0	8.78	2.5	2.00	2	1.60	15.5	12.38	6	2.06
Plow—												
Walking, 14-inch	28.50	14	11.4	3.26	4	1.14	2	0.57	17.4	4.97	6	0.83
Sulky	85.50	16	10.6	9.05	4	3.42	2	1.71	16.6	14.18	14	1.01
Gang, 24-inch	123	15	11.0	13.51	3	3.69	2	2.46	16.0	19.66	16	1.23
Tractor 2	110	9	15.4	16.89	3	3.30	2	2.20	20.4	22.39	16	1.40
Tractor 3	150	9	15.4	23.03	3	4.50	2	3.00	23.4	30.53	16	1.91
Roller	125	16	10.6	13.24	0.5	0.63	2	2.50	13.1	16.37	7	2.34
Seeder—												
Broadcast	57	16	10.6	6.04	0.5	0.29	2	1.14	13.1	7.47	4	1.87
End-gate	30	16	10.6	3.18	0.5	0.15	2	0.60	13.1	3.93	4	0.98
Threshing machine	885	15	11.0	97.17	2	17.70	2	17.70	15.0	132.57	16	8.29
Tractor, 10-20	850	8	16.8	152.38	2	17.00	2	17.00	20.8	186.38	35	5.32
Wagon	132.5	24	9.4	12.51	2	2.65	2	2.65	13.4	17.81	80	0.22

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[1] From *Bulletin 260,* Iowa Agricultural Experiment Station, Table V, p. 275.

Few farmers keep records of the cost of the machines they use or of the days of use and service given by them. Research workers in agricultural experiment stations have made surveys and cost-accounting studies which supply data that will enable

TABLE XXII—Distribution of Total Annual Expense of Implements[1]

Kind of Implement	*First Cost of Implement*	*Annual Expense*		*Annual Expense For*		
		Total	*Per Cent of First Cost*	*Depreciation*	*Repairs*	*Other Items (*)*
Wagon	$57.07	$4.56	7.99	$1.64	$0.67	$2.25
Hayrack	17.92	1.87	10.43	1.03	.13	.71
Gravel bed	6.49	1.11	17.10	.34	.51	.26
Truck	417.70	62.37	15.18	37.97	7.90	16.50
Auto (farm share)	303.92	47.85	15.74	31.33	4.52	12.00
Tractor	697.59	93.43	13.39	54.90	10.98	27.55
Gas engine	56.54	5.70	10.08	2.95	.52	2.23
Tractor plow	94.37	15.51	16.44	6.64	5.14	3.73
Tractor disc	80.28	8.73	10.87	4.64	.92	3.17
Walking plow	15.13	2.17	14.34	.66	.91	.60
Gang plow	44.48	5.08	11.42	2.22	1.10	1.76
Sulky plow	36.12	4.73	13.10	1.69	1.61	1.43
Disc harrow	45.51	4.48	9.84	2.45	.23	1.80
Spring harrow	21.06	2.07	9.83	1.02	.22	.83
Spike harrow	20.92	1.86	8.89	.99	.04	.83
Cultipacker	63.16	5.98	9.47	3.19	.30	2.49
Roller	20.12	1.57	7.80	.74	.04	.79
1-row cultivator	30.40	3.28	10.79	1.38	.70	1.20
2-row cultivator	68.40	7.24	10.58	3.41	1.13	2.70
Rotary hoe	81.47	8.36	10.26	5.12	.02	3.22
Corn planter	64.22	6.52	10.15	3.20	.78	2.54
Corn binder	105.30	10.44	9.91	4.97	1.27	4.20
Corn elevator	213.86	18.73	8.76	8.70	1.58	8.45
Grain binder	158.15	16.88	10.67	7.39	3.24	6.25
Grain seeder	19.73	1.79	9.07	.91	.10	.78
Grain drill	80.98	7.36	9.09	3.75	.41	3.20
Fanning mill	18.27	1.29	7.06	.57	.005	.72
Mower	54.47	7.05	12.94	2.78	2.12	2.15
Hay loader	79.39	7.21	9.08	3.75	.32	3.14
Hay rake	42.96	3.99	9.29	2.00	.29	1.70
Double harness	39.75	3.94	9.91	1.88	.49	1.57
Cream separator	74.46	7.51	10.08	4.07	.50	2.94
Brooder stove	18.42	2.22	12.05	1.42	.07	.73
Manure spreader	115.96	11.87	10.24	6.33	.96	4.58
Feed grinder	67.84	6.56	9.67	3.58	.30	2.68
Total of 35 implements	$3,332.41	$401.31	12.04	$219.61	$50.02	$131.68
AVERAGE FARM	$2,010.00	$242.00	12.04	$132.37	$30.25	$ 79.38

* Other annual expense was estimated for each machine as follows: Interest was charged at the rate of 5 per cent on average investment, or 2.5 per cent of new cost, during each year of service of the machine. Taxes were charged at the rate of $1.50 per $100 valuation, or 0.75 per cent of new cost, during each year of service. Housing was charged at 1 per cent of average investment, or 0.5 per cent of new cost, during each year of service. Insurance was charged at the customary rate of $3 per $100 of insurance for a five-year period. It was assumed that machinery was insured for two thirds of its value. Hence, the annual cost of insurance was 0.20 per cent of new cost during each year of service. Therefore, "other annual expense" as used in this Table constitutes a flat charge of 3.95 per cent of new cost of implement.

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[1] *Bulletin 437,* Indiana Agricultural Experiment Station, Table VI, p. 10.

one to estimate with reasonable accuracy the life and possible service of many forms of farm equipment. The results of these studies are reported in experiment station bulletins and are available to anyone interested. To enable students to analyze the problems of equipment costs as they come up in class exercises, summary Tables from two such bulletins are included. By substituting local prices and records of days of service on individual farms for those given in the Tables a close estimate of the cost of service for many machines and implements may be made.

The figures given in Table XXI may be used unless data from records kept on the project farm over a period of years are available. Where one can establish one's own first cost, life of machine, interest rate, cost of repairs, and housing costs, more accurate results can be obtained for the individual farm. There will be variations, too, in the number of days a machine is used which influence materially the cost for a day of service.

Table XXII gives data on the annual expense of certain implements and on the distribution of that expense as between depreciation, repairs, and other expense on a group of Indiana farms. The "other items" include interest on investment, taxes, housing, and insurance charges.

The total annual cost of service in Table XXII is given as a percentage of the first cost and may be applied to any first cost. In case the days of service vary from the normal average for a particular instance, a new cost per day may be obtained by dividing the total annual cost by the actual days of service.

Suggestive Questions

1. Is your home project farm overequipped with buildings?
2. How many kinds of power are available for your farm work?
3. Is animal power or tractor power best adapted to your farm needs?
4. How many days' work are there for a self-binding harvester on your farm?
5. Is it used to its full capacity?
6. What machines would you consider it wise to add to your farm equipment?

Suggestive Activities

1. Calculate the cost per acre for the use of a five-foot horse-drawn mower. Use the formula given on page 80.
2. Learn from your parents or from book records, if available, the first cost of the principal machines used on your farm.
3. Compare the present inventory value with the first cost and divide the difference by the number of years used to get the depreciation per year.
4. From this depreciation determine the percentage rate.

CHAPTER VII

FARM MARKETING PROBLEMS[1]

Modern agriculture has become exceedingly complex. Less than one third of the population of the United States is engaged in agricultural production. Those so engaged must produce the elementary food and clothing, not only for themselves, but for those who do not live on farms, as well. They in turn require various forms of goods produced by those living in towns, cities, or elsewhere and not engaged in farming. The foodstuffs and other commodities produced must often be assembled, sorted, graded, processed, packaged, stored, and transported long distances before being distributed among buyers and consumers. The exchange of commodities between producers and consumers has resulted in establishing local and terminal markets for the distribution and exchange of goods. The problem of getting the products of the farm into the possession of the consumer has become so complex that, on many important products, only one fourth to one third of what the consumer pays for the product goes to the farmer who produced it. The balance is divided between transportation charges, commission men, jobbers, wholesalers, retailers, or others who contribute something to putting the goods in final form and condition before they reach the consumer. Production is and always will be the major function of farmers. They will be wise, however, to give serious study to marketing problems, in order to know that they are getting full value for their products. Efficient marketing service greatly influences the profits from farming.

HANDICAPS IN FARM MARKETING

Only a few farmers have facilities for marketing their products in the most efficient way. As a rule, sales are made on a local market by the individual farmer when he has something ready to sell. At times, if he is in urgent need of money, he often sells at a sacrifice. Whatever he has to offer is placed at the nearest local or terminal market and the seller takes what he can get for it. The individual farmer acting alone has but little influence on the market. He does not have enough of any product to affect demand one way or the other. Seldom is there enough of a product from one farm to ship in large lots or carloads to a better market. The seller in such cases has no other recourse than to take what the local market man is willing to pay. If the seller knows the value of his product and is good at driving a bargain, he may get all it is worth on that market.

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[1] A full discussion of marketing activities as related to farming, together with an explanation of the technical organization of marketing institutions both private and co-operative, will be offered in Book IV of *American Farming*. The discussion in this chapter relates only to the marketing problems farmers meet in disposing of the products raised.

Good products marketed in small lots on the same market with poorer products are used by the buyer to bring up the average of a lot or carload when sold. The seller of good products on such markets is likely to get less than full value and the seller of poorer quality products may get more than full value for his. Where only staple products, which are graded and imperishable, are to be marketed the problem is not so serious. But, if the product is perishable or valuable and must be marketed as a specialty, business ability in selling is one of the most essential qualifications of a farm manager.

STEPS IN THE PROCESS OF MARKETING

Marketing is not a continuous everyday matter with farmers. Some kinds of products, like milk or cream or berries in season, may be taken to market daily. Most commodities, however, are seasonal and are offered on the market at irregular times. To get the best possible prices for such commodities, plans must be made ahead of time and preparations for marketing developed.

Study the Market Reports. To sell goods successfully and at a profit one must be familiar with probable supplies of the commodities to be offered for sale and the demand likely to be made for them on the domestic and world market. Fortunately, there is now established in the United States Department of Agriculture a comprehensive and reliable crop and livestock reporting service that will supply without charge much information on these questions. The Department also publishes at frequent intervals for free distribution Outlook Reports that give much statistical data on the prospective production and movement of the principal agricultural products. Price ranges are given and charts are supplied that show trends and cycles in both production and prices. One wishing to keep informed on market conditions should ask the United States Department of Agriculture for the Outlook Reports as issued, and particularly for the reports on the commodities he is producing. Because of the great volume of production in the United States and the wide variety of commodities produced these reports cover many more than are of interest to any one farmer. From the information offered one may select that which applies to his own need. Much information of value is contained in *Crops and Markets*, a monthly journal, also published by the Department. A brief summary of general agricultural conditions is published monthly as "The Agricultural Situation." It gives timely advice on important commodities and on the general conditions prevailing that influence market outlets and prices. It will be mailed by the Department to anyone desiring it at a subscription price of fifty cents a year.

Market news is given by radio service also and often enables one to take advantage of short-time fluctuations in putting livestock or other products on a near-by market. Those who are willing to make the necessary effort to learn about market conditions will find abundant information available to them in reliable government publications. Judgment and decision must be used, however, in applying the information to local situations.

When Is the Time to Sell. The obvious answer is to say, sell when the product is ready and a good price can be obtained. But having the product ready at a time when good prices can be obtained is not always possible. Some products, such as grain, corn, hay, and processed products, can be held for a considerable time under good storage conditions; but storage is attended by risk of loss from weather, fire, and vermin. If stored for some time, insurance should be carried, which adds to the expense. There is always a chance, too, that the expected price improvement will not be realized. Expense, too, has been added to marketing the product and can not be recovered. Loss of flavor and quality is experienced also, if products are stored too long.

Most products from the farm sell best when fresh. Few farms have facilities for storing fruits, berries, or other quickly perishable products in quantity. Apples can be held for a time; but, as a rule, they are sold as harvested. The fruits can be kept in cold storage, if such facilities are available; but, again, that storage adds to the expense and does not always insure better prices.

Cattle, hogs, sheep, and poultry, to be sold for meat purposes, can not profitably be carried for any great length of time after they have reached the finished form. The rate of gains made from feed consumed declines as high finish is reached and the cost per pound of gain rises. Animals can be profitably carried for a few days and sometimes for a month or two past the prime finish, when market conditions are improving; but, usually, it is best to sell when they have reached the weight and form required by the market. The skill and judgment of the operator should be used in determining when to start the animals on feed and in bringing them to marketable form at a favorable time rather than in trying to carry them after they have reached satisfactory finished form.

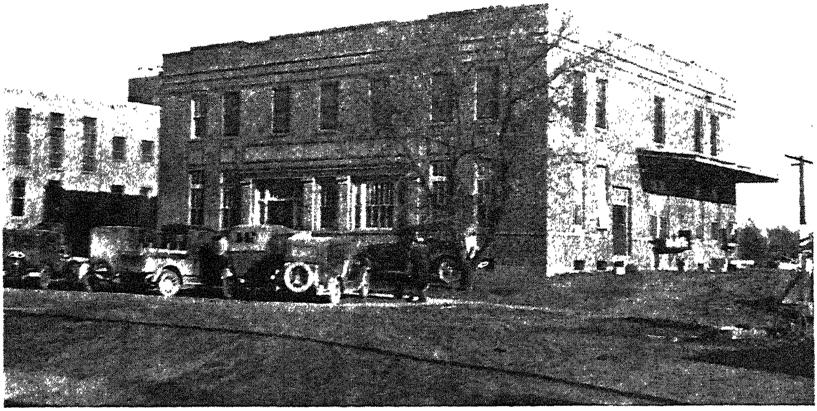

Figure 15. A modern co-operative creamery. To permit the manufacture of high-quality dairy products, milk and cream must be delivered daily while sweet and in good condition.

The products of the dairy are sold from most farms in the form of whole milk, cream, or butterfat. To sell well in any of these forms the product must be clean, fresh, and sweet. Few farmers have facilities for keeping it in cold storage. It must, therefore, be delivered daily at a creamery or other marketing point. There is little opportunity to gain marketing advantage for these products by holding or storing them on farms. When milk is converted into butter or cheese, the products can be held indefinitely in suitable cold storage plants. Large quantities of butter, cheese, and eggs are bought by speculators when prices are low and held by them until a favorable market insures a profit. Such operations influence the prices farmers receive for milk, butterfat, and eggs, but are not under their control.

There are always questions as to when and where to market finished products that are ready to be sold. Some farmers favorably located and on good roads can get radio market reports and truck their products to market on short notice when prices are favorable. Others must ship when ready and hope to reach the market at a favorable time. The best opportunities for most farmers to market at a favorable time lie in following long-time forecasts of supply and demand offered by the government reports. One can not always interpret these forecasts correctly, but individuals who give close study to them will, over a period of years, make fewer mistakes in marketing. Products should be produced on the promise of prospective prices when the product will be ready to sell rather than on the prices prevailing when the plans are made. The farm operator will do well to remember that in these days of quick transportation local supplies do not determine the prices paid at the local market. That fact is one of the chief reasons for keeping informed on probable supply and demand in the United States and world markets. Well-planned and well-timed production yields the best returns for labor and materials used.

How to Market. Whether farm products should be retailed direct to the consumer or sold through a commission or marketing agency will depend on local conditions. The real question is whether or not the farmer can earn more for the time spent in selling than he can for the same time spent in producing more product. Usually farmers are so fully occupied in growing and preparing their products for market that it is best to leave the distribution to other agencies. When the products from many farms can be combined in one distributing agency, cost of distribution can be greatly reduced. Those operating such agencies are often better informed and more skillful in placing the products than those who produce them. Better prices, therefore, are obtained and paid by them than the farmer would realize were he to undertake their distribution himself.

Roadside Markets. Roadside markets are a relatively new development in the marketing field. That not all roadside markets are successful is plainly evident to anyone who travels the highways and will observe. Facilities for offering the goods range all the way from hand carts, rusty automobiles or trucks, to well-arranged, fully-equipped merchandising establishments with curb service. These often have cold storage plants for preserving the perishable products until they can be sold. Such roadside markets are usually located just outside of large centers of population where a large volume of business can be done. Farmers on near-by farms often dispose of their products at such markets, but do not deal directly with the buyers.

Less pretentious roadside markets sometimes are set up for seasonal operation by farmers located on a main highway. These markets are open only at such times as there are products of good quality in abundance for sale. Berries, melons, apples, grapes, and other fruits find ready sale when well graded and attractively packaged. Buyers will pay approximately the retail price charged at the nearest city markets. Eggs, poultry, milk, cream, and honey are other products that often can be sold to advantage at such markets. The gain in prices received for goods sold must be sufficient to pay for the time of the attendant who gives the service. Roadside markets can not be given a blanket endorsement. Many of them tell their own story of disillusionment by rusty signs, and dilapidated housing or abandonment.

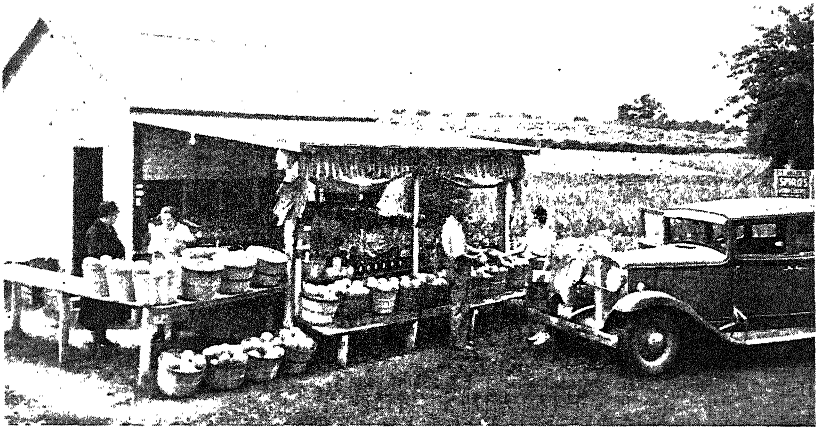

Figure 16. A modest, well-arranged roadside market where a farmer finds ready sale for truck crops, eggs, and flowers.

Good location, attractive display of high-quality products, fair prices, steady and reliable supply, prompt service and attention to customers are among the essentials for a successful venture. Easy access and "a place to park" are important features of the roadside market.

Quality Commands a Premium. Much can be gained in market prices for farm products by careful preparation and finishing of the goods or article to be sold. Grain containing weed seeds, dirt, and foreign matter must be cleaned before it can be used. If the buyer must clean it, he must buy at a figure low enough to pay for the cleaning. The seeds and foreign matter may have value as livestock feed. Were the farmer to clean it, he would not only get a better price for the grain he sells, but could retain the screenings for feeding purposes. The aim should be to produce clean grain, free from weeds and of good quality, for which a premium can be demanded. If produced in sufficient quantity, shipment to a terminal market can be made when the local market refuses a satisfactory price.

The special preparation of certain articles of produce deserves careful consideration. Most markets pay a good premium on freshly-gathered eggs. If eggs are gathered daily, well cleaned, marked with the date on which gathered, and shipped promptly in cartons, a much better price can be obtained than if sold unpacked or traded to the local grocer. By adopting a trade-mark or trade-name and paying attention to the demands of the purchaser a fancier price can sometimes be secured. It is not unusual for farmers to obtain a premium of from two to five cents, or more, a dozen on high-quality eggs attractively presented to the consumer.

Butter, hams, bacon, poultry and other articles of produce can be sold at an advance over the regular market, if they are of high quality and prepared in an attractive way and offered in a reasonably constant supply. The labor required for the preparation of such articles for market may be well repaid if wisely expended. One must avoid fussing over them so much as to raise the labor costs beyond the possible extra margin in price. To sell promptly, the goods must be attractive.

One of the essential points in establishing a special market is to provide a regular supply. Nothing is more fatal to a fancy trade among special customers than disappointments in not receiving either the expected quality of goods or the expected supply. Attention to regular deliveries and to furnishing products that are always up to the trade-mark standard is essential to success in catering to a special market.

Study given to the style of package that best pleases customers is well worth while. The size of the package in which the special products are to be marketed should be given thought.

It must be shaped to conform with the transportation facilities available and to put the article before the customer in good condition. Plums, grapes, tomatoes, and other soft fruits and vegetables carry best in small packages. They also sell best in such packages at retail prices. Sorting, grading, and labeling of all fruits and most vegetables will help to secure good market prices. In fact, sorting and grading are important factors in the preparation and selling of most farm commodities.

In selling livestock it is important to have the animals in good condition at the time of sale. Animals in good flesh and clean always sell better than those in thin flesh and poorly cared for. Dairy cows sell best with their second or third calf. Brood sows ready for the second litter of pigs are the most valuable, if in sound condition. Yearling and two-year-old ewes will bring the best prices. Most stock sold for meat should be sold at the weights and ages demanded by the markets when it can be finished profitably to that point.

CO-OPERATIVE MARKETING

Reference has been made to the fact that most farmers produce relatively small quantities of many products which they themselves can not market to good advantage. They also buy in small quantities and often at a disadvantage in price. One of the discouraging features in farming may be said to be that the farmer, acting individually, is under the necessity of selling at wholesale and buying at retail. Attempts to remedy this situation through co-operative buying and selling have opened to many farmers opportunities to improve the net income from their farms.

Advantages in Co-operative Selling. One of the chief advantages in co-operative selling lies in assembling in one place large quantities of a product. When assembled, it can more readily be prepared or conditioned. Because there is enough for full trucks or carloads, transportation costs are less per unit of product. Markets for full carloads are available which could not be utilized in marketing small lots. A capable manager of a co-operative marketing agency is likely to keep more fully informed on market conditions than the farmer operating alone, unless he is a large-scale producer. Handling the product in large bulk often gives the seller an advantage in bargaining power which will result in better prices. Not all co-operative selling organizations succeed. There are records of many failures. Enough have succeeded under good management to demonstrate their value as marketing channels for farm products. Co-operative creameries, cheese factories, grain elevators, and livestock shipping associations have been among the most successful of the co-operative selling agencies. Farmers should make contact with local co-operative agencies and learn the advantages offered through membership.

Advantages in Co-operative Buying Associations. There are also opportunities for gain in buying in large quantities. Farmers, acting alone, are usually forced to buy in small quantities and at high prices. By combining orders with neighbors wanting a quantity of the same products a truckload or a carload may be purchased at a price reduction. There will be saving in transportation costs also. Buying organizations have been set up by farmers in many states for the purpose of buying in quantity for redistribution among the members. The Grange Federation League of the Eastern States has been highly successful in the purchase and distribution of dairy-cow and poultry feeds at favorable prices. These are processed, when necessary, repackaged, and distributed among the members at a cost materially lower than they could be purchased in small lots by individuals. The State Farm Bureau Federations perform a similar service for Farm Bureau members in the purchase and distribution of grass seeds, fertilizers, machinery, and other materials. The Farmers Union Marketing Organization also assists its members in securing favorable prices on tractors and other heavy machines and implements, in buying oil and gasoline, and many other commodities. Land O'Lakes Creameries, which was organized as a selling agency, now serves also as a buying agency for its members. Land O'Lakes Creameries is a federation of farmers' co-operative creameries, located over a wide area of the dairy region. These are brought into a federation with a central headquarters from which the main selling and buying activities are conducted. Creamery and dairy equipment, dairy and poultry feeds, fertilizers, and many other supplies used by farmers and dairymen can be purchased through the organization at favorable rates.

The co-operative organizations named are only a few of many such organizations spread over the United States. They assist the farmers in their marketing problems. Those named are typical and representative of co-operative organizations. Fruit-growing co-operatives on the West Coast, tobacco growing co-operatives in the tobacco-growing regions, and many other forms will be found that are giving service in either selling farm products or buying supplies for farmers.

Farm operators should make it a point to become acquainted with local co-operative agencies and make use of the facilities offered by them when such procedure promises better returns for the products to be sold.

Co-operative Marketing Increasing. There has been greatly increased activity in co-operative marketing in recent years. Local co-operative marketing associations of one kind or another have been organized in large numbers to handle many of the staple products. In some cases material gains have been made in so doing. In other cases the gains have been negligible or loss has resulted. These experiences indicate that farmers will do well to give consideration to marketing co-operatively whenever the prevailing private marketing system is unsatisfactory. Efficient co-operative marketing must be built upon well-founded and loyally-supported locals. When these local associations have been properly organized and able leadership has been provided, it may be possible for these locals to be associated in still larger marketing associations to advantage. The organization of local livestock shipping associations into state associations and of local co-operative creameries into district, state, and federated associations, are examples of what may be done under able management. The advantages from such associations lie in the possibilities of standardizing the goods, in improving the quality, in shipping in larger quantities, and in stabilizing the market to a greater or less extent.

Co-operative marketing should not be regarded as a panacea for all the evils that have crept into private marketing systems. It can be of value only when it supplies the same service for less expense or performs a service that will increase the profits without increasing the expense of marketing. If a co-operative marketing organization is to succeed, it must have (1) a sufficient volume of business to employ capable management and the necessary facilities, (2) business management at least as good as that found in private marketing, (3) accurate accounting on which to build good business practices, (4) sufficient capital to provide the necessary facilities for operating and for conditioning the products, and (5) a loyal membership that will maintain a constant volume of business. In short, it must furnish better and more economical marketing service than that furnished by the system it displaces or with which it competes.

Suggestive Questions

1. What proportion of the price paid by the consumer for farm products goes to the farmer who produces them?
2. Who gets the rest?
3. What are the principal handicaps in farm marketing?
4. How can a farmer learn about market demands, supplies, and prices?
5. What are the advantages gained by marketing co-operatively?
6. What are the essential factors in a successful co-operative marketing agency?

Suggestive Activities

1. Get a list of prices paid at the local market for the commodities to be sold from your home farm.
2. Compare the prices thus obtained with prices received by those marketing elsewhere.
3. Make a survey of the farms in your community to discover articles prepared for and sold on some special market.
4. List all the co-operative marketing agencies operating in your community, together with the volume of business done by each.

CHAPTER VIII

PRODUCING HOME AND FARM SUPPLIES

Usually there is a wide margin between the price a farmer gets for a commodity and the price the consumer pays for that same commodity on the local market. Estimates made by the Bureau of Agricultural Economics, United States Department of Agriculture, indicate that for the period 1922 to 1930 farmers received about 48 per cent of the consumer's dollar for an average of 58 food products sold.[1] Variations in the margin received for different classes of products are due in large measure to the amount of processing involved before the article is ready for use. On highly concentrated articles such as eggs, potatoes, dry beans, and dairy products, where but little processing is required, the farmer gets a relatively high percentage of the consumer's dollar. On others, such as canned foods, the percentage received may run as low as 15 to 25 per cent. If farm products are sold on a local market through the usual channels of trade, the farmer gets less than half of what the consumer pays. If at the same time similar goods are repurchased in processed form, the farmer pays a high price for foods that could be processed on the farm. This inequality is particularly true on the family-sized farm where the preparation and processing can be done in slack times or by labor that would not otherwise be employed. In periods of low prices for farm products it is especially important to provide home supplies so far as possible, as the share the farmer receives for his products declines rapidly. Farm families on limited income will be wise to provide as much of their food supplies from the farm as possible. They will thereby save out-of-pocket expense and increase the net cash income.

What has been said of the family food products will hold true also for feeds needed to carry livestock through the year. While farmers can often buy feeds from neighboring farmers at nearly the farm price, handling and transportation costs must be covered in addition to the price paid. If purchased at a local elevator or feed store, storage charges also will be added. If purchases must be made, they should be limited largely to grains and high-protein concentrates which can not so well be produced on the farm. An abundance of the grasses and coarse forages is possible on most well-planned farms.

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[1] *Price Spreads Between the Farmer and the Consumer.* Bureau of Agricultural Economics, United States Department of Agriculture, 1936.

FOODS FROM THE FARM

A satisfactory and healthful diet for the farm family requires a wide variety of foods. Many of the foods required can be produced on the farm, under planned production, if the needs are carefully considered.

More than half of the average ration for human beings is made up of carbohydrates, the class of foods represented by sugars, starches, and the fibrous material of food plants. Although the fibers are largely indigestible, they are of importance in providing the bulk of material necessary for the normal muscular action of the stomach and intestines.

Fats are essential to a well-balanced diet. Proteins and many of the fats are gained largely from animal sources in the form of meat, milk, and eggs. All these food elements, together with the vitamins now found to be so important in the human diet, are contained in cereal, vegetable, and animal products that can be easily grown on most farms. A discussion of the principal groups of food products follows.

Cereals. The cereals are regarded as the most important of all food sources. They form the major part of the food supplies for the human race. Wheat, oats, barley, rye, and rice are the principal cereals used for human food. Corn and sorghum grains, though not classed as cereals, are used also as food at times by many people.

Because the cereals, with the exception of rice, must go through one or more processing operations before they can be prepared for food, their direct use as food is negligible. Wheat must first be reduced to flour, which goes through many bolts or sieves before it comes out as white flour. Oats must be hulled and rolled before it is used as a breakfast food or for other purposes. Barley must be pearled or ground and refined before using, and rye also must be refined. For these reasons farmers frequently have their cereals processed at a local mill or exchange them for products already milled. In most cases, however, the cereals are sold or fed to livestock and the cereal food products needed by the family are purchased at the local store. Wheat may be cracked or ground into whole wheat flour for special uses, as breakfast food, and even for coarse bread; but the quantity so used is negligible.

Potatoes. The Irish potato is one of the world's staple food crops. Because it needs no processing other than cooking before it is ready to eat, it is regarded as the "poor man's food." In centers of dense population where the climate permits its growth, it often forms the chief diet of families in the low-income class. Because it is a highly carbonaceous food, it should be balanced with protein and fat-bearing foods to insure good health. In most American homes potatoes are a regular part of the daily diet. For those engaged in heavy labor they are often served at each meal. Between three and four bushels of potatoes are required annually for each man, woman, and child in America.

The sweet potato, grown widely in the South, where the climate is not so well adapted to Irish potatoes, is also an important food crop. It is used principally in the South, where it replaces the Irish potato in the diet. Many sweet potatoes are shipped into the northern markets, however, where they find a ready outlet as a delicacy or to give variety to the diet.

Fortunately, both Irish and sweet potatoes can be safely stored for several months in cool cellars or in earth pits. Both crops are easily grown and there is no good reason why any farm family can not be liberally supplied with this staple food. Provision of five or more bushels for each adult, or equivalent, will give sufficient potatoes for use and seed for the next crop. The amount of land required will be small, as 100 bushels or more are normally produced on an acre. One fourth to one half acre will give enough for most families.

Vegetables. Every farm family should be provided with an abundance of vegetables, not only for summer use, but during the winter. The broad-leafed vegetables, such as lettuce, spinach, and Swiss chard, are rich in vitamins, when used fresh from the garden. Carrots, parsnips, rutabagas, squash, pumpkins, cabbage, and many others may be stored for winter use without processing. Tomatoes, sweet corn, string beans, peas, and others are easily canned or processed, in which form they may be kept indefinitely. A fair-sized, well-planned garden can be well cared for by the members of the family in odd moments not required for other tasks. The products from such a garden will pay good returns in health and satisfaction. It will, at the same time, reduce the expense for family food.

Fruits. Fruit-raising is, on the whole, a highly specialized type of farming and best conducted only in areas especially adapted to it by soil and climatic conditions. This statement does not mean, however, that farmers advantageously located may not find it advisable to have a few fruit trees to supply at least a part of the family needs. A half dozen or more apple, pear, or peach trees, well cared for, will supply most families with fresh fruit in season and with a surplus for canning or storing. Many, however, must depend upon commercial orchardists for their supplies.

Figure 17. A farm garden suited to the size and needs of the home will not only save expense for foods but add to the health and enjoyment of the family.

The small and bush fruits are adaptable over a wider area than the tree fruits. Where moisture conditions are favorable and family labor is available to provide the care, generous provision should be made for the small fruits. Strawberries, raspberries, currants, and gooseberries are easily grown. Used fresh, in the canned form, or as jams and jellies, they make a welcome addition to the diet. They will be used much more freely if homegrown than if they must be purchased.

ANIMAL FOOD PRODUCTS

While animal food products are usually more expensive than cereal and vegetable foods, they are much more commonly used.

They are more expensive, because they have first been converted from plants into a more highly concentrated form as meat or milk by some kind of animal. There is always some loss of energy in such conversion and the animal that makes it takes toll for the service performed. They are more commonly used because of their palatability and nutritive qualities. They furnish the protein to complement the carbohydrates of vegetable foods. Nature must have a complete balance.

Dairy Products. Dairy products are highly regarded as foods. Physicians and dieticians prescribe milk liberally as food for infants, invalids, and even for adults in good health. Raw cow's milk is an almost perfect food. Cream, butter, and cheese are other forms of dairy products that are both nutritious and palatable. The milk, cream, and butter can readily be provided on most farms. For a family of five, two good cows will supply an abundance of these products.

To provide feed for two cows will require five to six acres of average farm land. For that reason, it may not be advisable for those operating small acreages to keep even one cow. Those on family-sized farms, however, can hardly afford not to provide one or more cows to furnish the family with dairy products.

Meat Products. Meat is a large factor in the diet of prosperous people. It has been noted that those countries having the greatest wealth consume the most meat. Studies have shown that farm families eat more meat than the families of working men in cities. The reason is probably because farmers dress their own meat animals and, therefore, their meat costs less than where it must be purchased at a retail market. There is little difficulty in providing fresh meat for the farm family during the winter season, when the carcass of even a large beef animal can be kept indefinitely in frozen condition. In summer a large carcass must be either processed by salting and curing or by putting a large part of it in cold storage. The cold-storage locker system, now widely in use, makes it possible to provide storage the year around at low cost. Where lockers are not available, some farm communities meet the problem by forming a meat ring. Then, when a heavy animal is dressed, the carcass is divided up among the members in quantities that each family can use before spoilage occurs. Adjustments are made for differences in weights of cuts and quality of meat.

The smaller animals, such as hogs, calves, and sheep, are best suited for the small family or for summer use, as the carcasses are small and can be used before spoiling. Mutton and veal are not so popular with farmers as pork. Hogs, therefore, supply the larger part of the meat used by farm families either in the fresh or the cured form.

Poultry Products. Poultry and eggs are much more commonly used by farm families than other food products. There are few farms in the United States which do not have at least a small flock of chickens or other poultry. Eggs have many advantages as a home-raised food. By good management they can be produced every day in the year. They take no processing, other than cooking, and can be kept for considerable periods of time without spoiling. Eggs are nutritious and highly nitrogenous and, therefore, well calculated to supply tissue-building nutrients to the muscles. Their value as a farm food should not be overlooked.

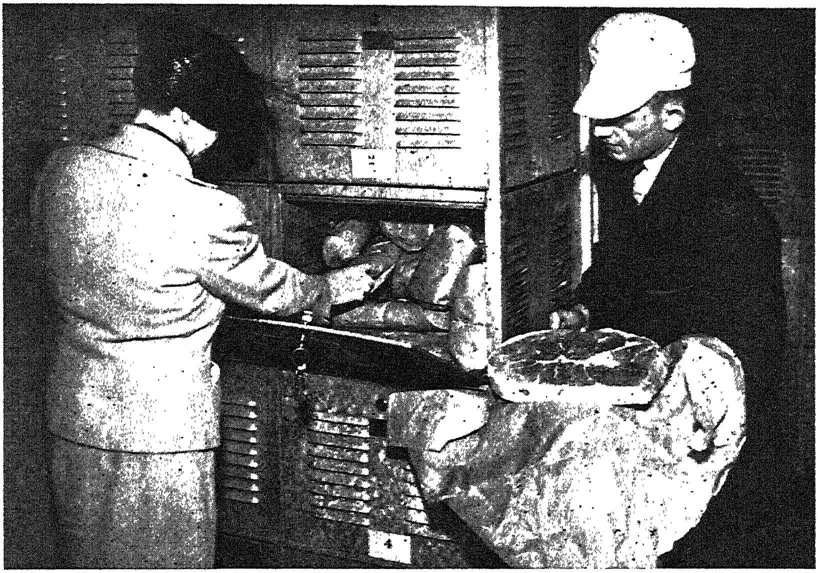

Figure 18. The cold storage locker makes it possible for the farm family to preserve meat and other products in fresh form until wanted.

Although not served so frequently, poultry meat is also universally a farm food. The poultry meat unit is small and well adapted to small families. Even during the heat of summer the meat can all be used before spoilage occurs. It is for this reason that chickens, particularly, furnish most of the fresh meat used by farm families during the summer season.

Another point in favor of poultry is that the average farm flock lives on what would otherwise be waste. Refuse grain, table scraps, skimmed milk, and other farm products, are excellent poultry feed and may well be utilized as such as a matter of good economy.

The poultry enterprise is especially adapted to the small farm. A flock of one hundred chickens will require about the same space and about the same quantity of feed as one cow. They are more easily housed and cared for and do not require the roughage rations required by cows. The poultry enterprise deserves a prominent place even on the small farm.

AMOUNTS OF FOOD USED

The problem of farm-raised foods for the family is sufficiently important to justify an examination of the experience of farm families. In a report from the University of Illinois, as given by Hudelson[1] records from 57 farms over a period of ten years, 1925 to 1934, the wholesale value of home supplies was shown to be $368.00 per farm family. Hudelson estimates that the cost of these supplies purchased at retail would have been $767.00. The saving to each family of approximately $400.00 is an item of real significance to the farm operator.

There is a wide variation in the quantities of farm-produced foods used by farm families in different sections of the country. There is variation also in the classes of food used. This variation is determined largely by the nature of the crops and livestock produced. In the fruit and cotton-producing areas the use of dairy products and meat is much more limited than in areas of diversified and livestock farming. Data of interest in this connection is presented in Table XXIII, which shows the amounts of the staple farm products used by farm families in ten states. Similar data for Minnesota farm families are given in Table XXIV.

QUALITY OF FARM FOODS

The quality of foods used by farm families may be of the best. There is a distinct advantage in being able to use them when at just the right stage of maturity to be most palatable and nutritious. Those who have enjoyed the privilege of eating tree and vine-ripened fruits are quick to detect the lack of flavor and quality in fruits picked green and ripened in transit. Strawberries, fully ripened, and fresh from the vines are much superior

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[1] Hudelson, *Farm Management*, pg. 240.

TABLE XX.—FARM-FURNISHED FOOD F IOME USI 'HE AVERA SUPPLY
A HOUSEHOLD* FOR A YEAI N AREAS R SENTING
DIFFERENT TYPES OF I M NG, 193.

Selected Counties in	Type of Farming Represented	Families Included	Average Quantities or Money Value of Food Produced for Home Consumption								
			Milk	Eggs	Poultry	Pork	Other Meat	Potatoes	Other Food from Garden	Fruits	Other Food‡
		No.	Gal.	Doz.	No.	Lb.	Lb.	Bu.	Dol.	Dol.	Dol.
Vermont..........	Dairy..........	513	326	124	17	139	112	42	43	4	7
Ohio.............	General........	814	212	146	36	440	155	23	38	15	5
Illinois............	Corn or cash grain.........	838	248	160	68	637	148	12	22	4	¶
Kansas...........	Wheat or cash grain.........	557	264	176	97	328	159	2	10	¶	¶
Colorado, Montana, South Dakota...	Range livestock and cash grain.	794	281	178	55	290	296	19	43	7	3
Oregon...........	General and fruit	1,611	251	138	35	195	119	14	45	23	1
Southern California	Fruit and nut...	1,080	93	74	20	8	11	1	6	11	¶
South Carolina:											
White..........	Cotton and tobacco.......	2,048	287	113	64	659	12	7	51	8	23
Negro..........		478	158	59	36	363	5	4	32	4	30

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* Non-relief families of farm operators, including husband and wife, both native born, 0-8 other family members, and household farm help.

‡ Includes syrup, molasses, honey, grain products, and cowpeas and other foods grown in fields.

¶ $0.50 or less.

to the same variety picked early and shipped to a central market. Sweet corn, gathered when at just the right stage, and cooked at once, is far more tender and palatable than that which is held in storage for even a day or two. Tomatoes, fully ripened on the vine, are much more attractive than the green tinged, pale pink ones so often found on city markets. The same arguments apply equally well to the vegetable and animal products that go to balance the family diet. Fresh milk and cream in abundance can be made available to most farm families. These, with fresh eggs and poultry supplementing the fruits and vegetables, will supply adequately all needs for building and maintaining the human body and for insuring its healthful functioning. To these may be added the meat products from one or more of the classes of animals kept on farms where the production program is well diversified. On such farms there is no justifiable reason for scanty food or an unbalanced diet for the farm family.

TABLE XXIV—QUANTITIES OF FARM PRODUCE USED IN HOMES IN MINNESOTA[1]

Item	*14 S. E. Counties 1935-38*	*Winona County 1935-38*	*Fillmore, Houston, Winona Counties 1935-38*	*Meeker County 1937-38*	*Farm-Security Clients 1936-37*
Whole milk, qts.	1,326	1,488	1,048	1,300	726
Cream, pts.	302	343	400	226	217
Farm-made butter, lb.*	6	1	21	3	61
Eggs, doz.	183	211	177	182	78
Poultry, hd.	40	88	32	20	19
Cattle, lb.‡	354	325	283	334	134
Hogs, lb.‡	519	786	531	516	321
Potatoes, bu.	25	38	26	20	21
Wood, cords	8	14	18	11	10

* Because of the widespread prevalence of co-operative creameries over the state of Minnesota, few farmers make butter. The cream is sent to the creamery where the butter is made and butter is returned for the use of the farm family, where it becomes an item of cash expense.

‡ Live weight.

PREPARATION AND STORAGE

The average farmer is more concerned with the preparation of food for his own use than for sale. Vegetables, root crops, and all foods stored in their original state should be carefully harvested, so as to avoid bruises and cuts. Surplus dirt should be removed and the product stored in a cool basement or root cellar. Ventilation should be adapted to provide air and moisture control. Every home should have a storage area for this purpose. Root crops may be stored in sand or coarse soil to preserve moisture and crispness. Cabbage heads may be wrapped in newspaper and kept in a cool place. Squash and pumpkins may be kept for a long time, if placed in a moderately cool, dry room. Apples and potatoes should be stored in specially prepared bins where the temperature is low but above freezing and the air somewhat moist. Careful checking occasionally to remove the decaying specimens is advisable so as to prevent the decay from spreading.

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[1] *Farm Business Notes.* University Farm, St. Paul. No. 196, April, 1939.

Preserving vegetables and fruits by canning is a common practice on most farms. The thrifty housewife plans for the winter months ahead by preserving as much food as will be needed. An estimate should be made of the food needed for family use and a proportionate amount for canning. It is not economical to can much more food than is needed simply because an abundant supply is available. Too often, if more than is needed is canned, spoilage occurs before the food can be used. Emphasis should be placed on fruits and those vegetables which are relatively scarce during the winter. Green apple sauce, properly canned, will aid greatly in planning the menu during winter months.

ANIMAL FEEDS

The advisability of providing generous supplies of farm-grown feeds for the livestock produced has already been stressed. The organization plan of every farm should be shaped to supply the feed needs of the animals kept and to supply power and productive ability. That plan must be revised and adjusted by the operator to provide the year-by-year need for feeds. It becomes important, therefore, to give further attention to the kinds of feeds used and to the quantities in which they will be needed. They may be classified into four major groups: (1) pastures, (2) forage crops, (3) silage and root crops, (4) concentrates. Location of farm, soil type, topography, and the number and kinds of livestock kept should determine the proportions in which these feed crops should be grown.

Pastures. Good pasturage crops are the foundation of economical livestock production. Grasses and legumes are the natural feed crops for nearly all classes of domestic animals. When cattle, sheep, and horses have free access to good pastures they make good growth and gain in weight or production. On such feed they need but little care or attention other than to see that fences are in safe order and that pure water is easily available. Because livestock can be cared for on good pasture crops with the least labor and at the same time do its best in the conversion of feed into milk, meat, or other product, the pasture season should be made as long as possible. To provide good pasturage over a season of 180 to 220 days will require foresighted planning and good management.

Kentucky bluegrass, timothy, and the native grasses of the prairies provide the permanent grass pastures of the North. Bermuda grass, Johnson grass, lespedeza, and native grasses are the principal pasture grasses of the South. These, like most other crops, are seasonal in growth and must be kept under control to get the best results for their use. The pasture grasses of the North start slowly in the spring and go into a resting period during the hot days of late summer. Earlier spring pasturage of good quality can be provided by sowing the fall previous a reasonable acreage of fall rye or rye and winter wheat mixed. In the South winter barley and winter oats, combined with winter wheat, furnish much winter pasture. If sown in the early fall, late August, or early September, the crop will provide some late fall feed and also early spring pasturage. Use of such annual crop pasturage until late May or early June will give the grass pastures a chance to make good growth before livestock is turned on, thus giving protection to the plant roots and prolonging the period of growth.

Figure 19. Good pastures are the foundation of economical livestock production.

Dividing the grass pastures into two or more fields and rotating the periods of pasturing is becoming a modern farm practice. In this way overgrazing is avoided and greater total production is secured. Less effort is required by the animals also in getting a full feed, and a larger proportional return of body weight or of other product results. Feed used in creating energy for transporting the body can not be used for the manufacture of milk or meat.

Top-dressing the permanent pastures with manure or with commercial fertilizers will in many instances result in better yields. Disking a portion of the pasture land lightly in early fall and applying a dressing of barnyard manure will increase the pasturage materially the next summer.

There is a growing tendency among farmers to combine alfalfa, biennial sweet clover, and other legumes with the grasses for pasture purposes. There is much to be said in favor of such practice. The legumes add bulk to the pasturage and improve the quality of the ration. They also add to the nitrogen of the soil through the bacteria living in association with the alfalfa roots and stimulate the growth of the grasses. Prejudice against the legumes as pasture crops, because of supposed danger from bloat, is being overcome by experience and good pasture management.

Because grass pastures are usually bare and short in midsummer, supplementary pasture crops are often advisable. Sudan grass is widely used in the North for this purpose. Lespedeza, soybeans, and other annual crops are used in the South and Central states. Mixtures of the cereals and Dwarf Essex rape are particularly useful as pasture crops for swine, sheep, and poultry.

Forage Crops. Second only to good pastures in economy of livestock production is an abundance of high-quality roughage. The ruminants, and horses, particularly, can and do utilize much cheap, bulky feed. This is usually supplied in the form of cured hay from grass and legume crops. Corn fodder, Sudan grass, the sacharine and nonsacharine sorghums, and even the cereal crops are at times and in some places also used as cured forages for livestock feeding. There are wide differences in the quality of the nutrients furnished in these forages and in the quantities yielded per acre of land. The legume hays made from alfalfa, soybeans, red and alsike clover rank high in total digestible nutrients as may be seen by reference to Table XXV. They also rank high in digestible protein which tends to reduce the quantity of high protein concentrates required to balance the ration. For these reasons and because large yields per acre can normally be grown, they should be given first consideration in the forage supplies.

Corn for cured fodder, for grain, or for silage also merits a large place in the forage supplies. Less labor is required in growing the legume hay crops than in growing corn, and, where good yields can be secured, legumes should be given preference.

TABLE XXV—AVERAGE AMOUNTS OF TOTAL DIGESTIBLE NUTRIENTS IN 100 POUNDS OF COMMON ROUGHAGES[1]

Kind of Feed	*Digestible Protein*	*Total Digestible Nutrients*
Dry Roughage	*Lbs.*	*Lbs.*
Alfalfa hay:		
Early cut	11.6	51.4
Medium early cut.	10.4	51.5
Late cut.	9.6	48.7
Soybean hay	7.9	50.0
Sweet clover hay	10.9	50.7
Red clover hay	7.4	49.6
Alsike clover hay	7.9	47.3
Mixed hay (½ clover, ½ timothy)	5.1	49.3
Reed canary grass hay	4.5	52.3
Sudan grass hay	3.7	51.4
Timothy hay	2.9	48.0
Prairie hay	2.8	48.3
Oats hay	4.7	45.5
Corn fodder	3.7	48.1
Oat straw	1.0	45.6
Corn stover	2.0	36.4
Wheat straw.	0.7	36.9
Succulent Feeds and Miscellaneous	*Lbs.*	*Lbs.*
Corn silage	1.2	16.8
Sunflower silage	1.0	13.7
Corn cannery silage.	1.1	17.8
Pea cannery silage	2.8	15.3
Potatoes	1.1	17.3
Sugar beets	1.3	11.5
Mangels	1.0	6.5
Rutabagas	1.0	9.5
Skimmed milk	3.5	8.7
Whole milk	3.3	16.2

[1] Compiled from Table V, *Bulletin 218*, Minnesota Experiment Station.

Amounts Required. The amounts of forage crops grown on any farm will depend upon the kinds and number of livestock kept. The average amounts required annually by different animals were given in Table V, Page 37, of *Agriculture II*. It is republished here to enable those planning forage supplies to calculate closely the amounts needed. In making plans for feed, one should remember that it is better to have a reasonable surplus than to run short of supplies.

TABLE XXVI—Approximate Amounts of Concentrates and Roughages Required by Various Classes of Livestock*

Kind of Livestock	*Corn, Grain and Other Concentrates Range—Lbs.*	*Hay Roughage or Equivalent (No Silage) Lbs.*	*Hay and Silage Combination*	
			Hay Range—Lbs.	*Silage Range—Lbs.*
Horse ....from	2,000-3,000	2,000-3,000	2,000-6,000	
Dairy cow—				
200 pounds butterfat.	700- 800	5,000-6,000	2,000-3,000	5,000- 8,000
300 pounds butterfat.	1,400-1,600	5,000-6,000	3,000-4,000	6,000-10,000
400 pounds butterfat.	2,100-2,400	5,000-6,000	3,000-4,000	6,000-10,000
Beef cow or 2-year-old.		5,000-6,000	3,000-4,000	4,000- 5,000
Dairy heifer, 2-year...	500- 700	4,000-5,000	3,000-4,000	2,000- 4,000
Dairy heifer, yearling..	500- 700	2,000-3,000	1,500-3,000	1,500- 3,000
Beef heifer, yearling...		2,000-3,000	1,500-2,000	1,500- 3,000
Beef or dairy calf.....	300- 500	1,000-1,500	500-1,000	
Beef or dairy bull.....	600- 800	4,000-6,000	3,000-4,000	0- 4,000
Beef calf (fattening period)	2,500-3,000	1,250-1,500	1,000-2,000	1,000- 2,000
Beef yearling (fattening period)	2,500-3,000	1,200-1,500	1,000-2,000	1,000- 2,000
Ewe and lamb.........	100- 200	200- 300	200- 300	100- 200
Feeder lamb..........	100- 150	200- 500	200- 500	
Sow, birth to 15 mo....	1,500-2,000			
Hog to 200 pounds.....	700-1,000			
Hen	70- 80			
Pullet to 6 mo.........	30- 40			
Turkey to fall.........	70- 100			

*The quantities of feed indicated are approximate amounts required per year under average conditions. Conditions on a particular farm may warrant considerable variation from these quantities.

Pasture: Of good quality pasture, such as good sweet clover, lowland bluegrass, alfalfa, or rape for hogs, allow 1 acre for 1 to 2 cows, 1 acre for 3 to 5 head of young stock, 1 acre for 6 ewes and their lambs, 1 acre for 5 sows and their litters. Of upland bluegrass pasture, allow twice as many acres as of the above.

Other Considerations in Feeding: In planning grain requirements for the farm, the kind of grain should be taken into account. Nearly all classes of livestock except horses, require some protein supplement. Hogs and steers will require much more corn than small grains while being fattened. Other livestock will use a variety of grains. For many farms the total pounds required against the total pounds produced is the important balance to establish.

Quality of roughage is important in estimating quantities, both of hay and grain. The figures given are based on good quality. If the roughage is of poor quality, more grain usually is needed. Good quality corn fodder can be substituted for hay, pound for pound, up to a quarter or more of the total dry roughage in feeding cattle and sheep. Corn stover may be substituted for hay one half pound per pound. If good quality legume hay is fed, a dairy cow will make 200 pounds of butterfat with little or no grain.

Silage and Root Crops. One of the chief advantages of the grass crops in summer feeding lies in their succulence, or soft juicy, easily digestible substance. To supply such feeds in the winter season is somewhat difficult. To meet this difficulty many farmers have built silos in which to preserve forage crops in green and succulent form. This succulent feed is fed to livestock during the winter months largely to supply the place filled by the pasture crops during the summer season. Ensilage is especially popular with dairy farmers, because it enables them to maintain their cows in high production during the winter months, when milk and butterfat prices are highest. Corn is the most common and most popular ensilage crop, though many other crops may be so utilized. The sorghums, sunflowers, and other rank-growing forage crops are sometimes used. The legume and grass crops can be successfully ensiled by the addition at silo-filling time of molasses or other quickly reacting carbohydrate to start the fermentation process. The preservation of legume crops in this manner is rapidly gaining popularity.

Contrary to the common belief, ensilage is a relatively high-cost feed. The labor of growing the crop, coupled with the cost of erecting a suitable silo, the power, and the cost for machinery and labor needed for filling the silo make the cost high. To offset this, however, is the saving of nearly all the crop without loss, convenience of feeding, and, usually, increased production.

The silo is of doubtful economy on farms where small herds are kept. On farms where large herds of cattle are kept and where high production is desired, the silo undoubtedly has a place.

On small farms and in areas where the growing season is cool and short, root crops make a welcome addition to the feeding rations. Roots are high in water content and take the same place as silage in supplying succulence in the ration. Roots such as mangels, sugar beets, rutabagas, carrots, and turnips, when properly sliced or chopped, are much relished by cattle, in particular. Considerable labor is required to grow them and they must be stored where they will be safe from frost. Their principal place is for late fall and early winter feeding. If silage is not available, a supply of roots is a good substitute.

Concentrates. Because concentrates are more nearly in the foods class than grasses and forage crops, they are relatively higher in price. In livestock production it is good economy to make all the growth possible on the cheaper feeds. Concentrates should be supplied of the kinds and quantities best calculated to supplement the nutrients contained in the available roughages. Corn, grain sorghums, oats, barley, and other coarse grains can easily be produced on most farms in connection with livestock. Corn will supply the most feed, is most popular and palatable, and the most widely adapted for feeding purposes. It is also easily and cheaply stored for use. The coarse grains and corn should form the bulk of the concentrates in the feeding ration. Unless these can be produced in profusion on a farm, livestock production is not likely to prove a profitable venture. The purchase of concentrates should be limited to high protein feeds such as oil meal, cottonseed meal, tankage, and to such minerals as may be lacking in the feeds produced on the farm.

Suggestive Questions

1. What are two good reasons for producing farm supplies of foods and feeds?
2. Name the important types of nutrients required in the diet.
3. From what sources can these nutrients be most readily obtained?
4. Why are dairy products so highly recommended as food?
5. What are the reasons for the popularity of meat in the diet?
6. Which kind of meat animals supply the largest proportion of meat used by farm families?
7. What are the principal groups of animal feeds?
8. What are the chief advantages of pasture feeds?

Suggestive Activities

1. Make a chart of the different kinds of foods eaten in a day at your home. Show from what plant or animal each food came.
2. Make a table showing the amounts of meat and milk the family will require for a year.
3. Take a census of the canned goods in your mother's fruit cellar.
4. Map your home farm. Show the acreage of pasture, forage and grain crops.
5. Check with your local hardware dealer and determine the cost of erecting a silo. Make a list of the additional machinery needed for filling the silo and learn its cost. Compare the feeding value of a ton of alfalfa hay with a ton of corn ensilage.
6. Make a survey of the silos in use in your neighborhoood and of the crops used for silage.

CHAPTER IX

PRINCIPLES INVOLVED IN CROP PRODUCTION OPERATIONS

Many of the operations concerned with crop-growing are common to all crops. Others are specific for a special crop and not applicable to other crops. Plowing the land as a first step in the preparation of the land for cropping is an example of the first group. Hand-pollinating of corn in producing hybrid seed stocks is an example of the second group. Between these two extremes lie all sorts of operations more or less applicable to the production of many crops. Certain principles are here outlined which will be useful to the operator in determining when it may be wise to apply the standard treatment or resort to some special operation. The principles involved are:

1. Each crop should be given its most favorable environment and conditions for growth and development. Optimum conditions can not always be supplied; but, so far as possible, the natural-growth habits of the crop should be recognized and provided.

2. Each operation in the processes of producing each crop should be so timed as to give the most favorable conditions for growth and the development of quality in that crop. Spring wheat, for instance, germinates and stools best in the cool days and nights of early spring. Early-seeded wheat nearly always makes the best yields. Corn, soybeans, and Sudan grass, on the other hand, make the quickest germination and the best growth when planted later in soil well warmed by the sun's rays. Tillage operations and harvest likewise must be timed to provide the best conditions for promoting rapid growth and good quality.

3. Permanently productive land can be insured only by good handling and management. The operator of a farm must, therefore, keep in mind the need for restoring in some manner the elements of fertility removed with each succeeding crop. Plans for maintaining the producing power of the farm should be included in the cropping program. Barnyard manures and commercial fertilizers, combined with crop rotations and green manure crops, are the means usually employed.

4. Economy of operation is always in order. Economy does not mean skimping the operations. It does mean expending resources and labor where they will bring largest returns. There is nothing gained in using three bushels of barley seed an acre if two bushels will give an equal yield, as it usually does. One cultivation at the right time may be worth more than two given at the wrong time. On the other hand, an extra tillage operation may mean sufficient improvement in quantity or quality to bring greater returns on the market.

These are all matters that call for judgment and decision on the part of the operator. No rule for action can be laid down, but the principles outlined, if followed, will result in consistently good results from the crops grown. There are other matters common to many crops that bear on successful and economic production that will next be considered.

SOIL MANAGEMENT

Crop production is based largely on the soil and its management. Good crops are not grown on poor soil or on soil that is out of condition. Not all soils can be made suitable for cropping, but many can be improved by good management. One of the first points to observe is the moisture conditions. It is well known that plants can not grow without water. Neither can farm crops be grown if there is too much water. To maintain good balance in the soil, moisture supply, therefore, becomes a major problem.

Drainage is the remedy where too much moisture frequently leaves water standing in the fields. Drainage may be accomplished by either open ditches or by closed tile drains systematically laid. The latter, while more expensive, are the more desirable for several reasons. Tile drains buried beneath the surface present no obstacles to field tillage in any direction desired. Open ditches, if deep, cut the fields up into awkward shapes and often cause loss of time by extra turns or by long distances traveled to reach a crossing place. The extra cost of the tile may be offset in many cases by the saving of time in working the fields. Which method to employ is a matter that can be determined only by the operator, who, with assistance from a drainage expert, can figure out the relative merits and expense of the two systems of drainage for the land to be drained.

Space does not permit a discussion of drainage methods. Where fields are to be drained or a drainage system laid out for a farm, it is advisable to employ a drainage engineer familiar with drainage methods. Many of the State Experiment Stations have published helpful bulletins on the subject. They can be had for a post-card request.

Supplying Moisture. It is more difficult to supply moisture when there is a deficiency under natural conditions than to provide drainage when needed. In an irrigation district it can be supplied, when water is available, by putting in a system of irrigation ditches and turning on water when need for it is indicated. Only a small portion of the land of the United States is served by irrigation waters. Fortunately, large areas of good agricultural land are located in regions where the annual precipitation normally is ample for crop production. By correct tillage methods good crops can be grown even where precipitation is somewhat limited. To give moisture-conserving tillage requires knowledge of elementary soil physics and of the movement of water in the soil.

First, we should note what happens when it rains. Heavy rainfall is marked by two movements. Some of it runs off over the surface, seeking a common level through the force of gravity. This movement is plainly noticeable. At the same time some of the rain water is absorbed into the soil and moves downward, also by force of gravity, to the point where it reaches a static water level or reservoir. When the rainfall is light and the soil dry, gravitation will carry the water downward only to the point where gravity is overcome by adhesion of the water to the soil particles with which it comes in contact. Movement of water into the soil is not easily observed, but examination of the soil after a rain will prove the case. Numerous examinations by soil scientists give evidence that water percolates downward much more rapidly in porous, sandy, or gravelly soil than in dense clay or silt. The movement downward will be retarded if the spaces between the soil particles are well supplied with humus (organic matter), which will absorb and hold the water.

After the rain is over and the sun shines, the water in the soil begins to move up toward the surface. The sun and wind dry the surface soil and evaporation stimulates the movement of water upward by capillary action. The roots of plants come in contact with the soil particles and draw nourishment for the plant from the watery solution adhering to them. The plants move water out of the soil by transpiration through the tissues as growth is made. The size of the soil particles, the quantity of organic matter in the soil, and the tillage practices followed, vitally affect the movement of water into and out of the soil. They are, therefore, important matters in crop production.

Water moves downward rapidly in a coarse sandy soil. It often gravitates downward beyond the reach of the plants. Because of the coarse soil particles, capillary action is poor and crops on sandy land may suffer from drouth unless rains are frequent. The addition of manures or green manure crops that supply organic matter will improve such soils. The decaying organic matter acts as a sponge to absorb and hold the moisture within reach of the plants. While commercial fertilizers can be used on such soil, there is likelihood of much loss because of their leaching downward out of reach of the plants during periods of heavy rainfall. On clay and clay-loam soils the soil particles are smaller and the movement of water downward is much slower and the movement upward more rapid than on sandy soils. Such soils are less likely to be drouthy than sandy soils. There is also less danger of loss of fertility from leaching. Commercial fertilizers may, therefore, more safely be used on them, should the farm not provide sufficient barnyard manures for all the fields. By recognizing these well-established facts the farm operator can so modify the treatment of his fields as to insure the best possible moisture conditions for his growing crops on each field.

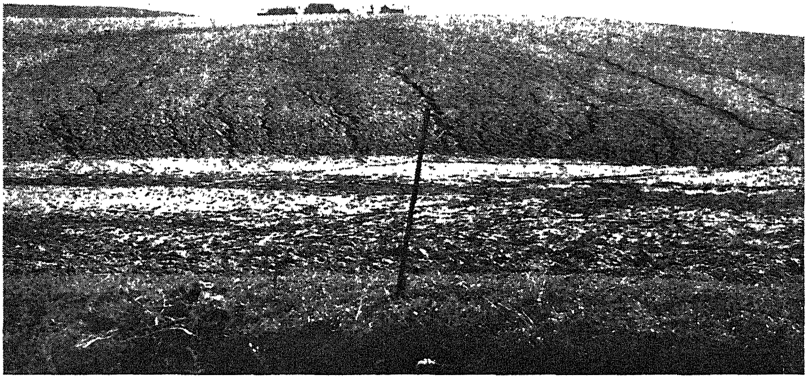

Figure 20. Rainwater running down the slopes carries with it the finer particles of soil, thus starting sheet erosion. The farm operator must constantly watch for signs of serious soil losses from this source.

Moisture can be accumulated in the soil also by retarding the run-off from heavy rainfall. Furrows drawn on contour lines along the sides of slopes or hills, to catch the run-off and prevent rapid flow over the surface, effectively increase the supply of soil moisture. The distance of the furrows apart will depend on the nature of the soil, the slope of the land, and the anticipated volume of rainfall. On the southern Great Plains plow furrows drawn 100 to 200 feet apart on nearly level grazing land have materially increased the quantity of water absorbed into the soil from rainfall. In areas of frequent heavy showers and quick run-off the furrows, or rounded ditches of greater depth, may be more closely spaced. The fall of the contour furrow should be so moderate as to hold the water in the furrows nearly level, thus increasing absorption and decreasing the danger of gullying.

SOIL CONSERVATION METHODS

American farmers are rapidly awakening to the importance of soil conservation. The United States Department of Agriculture, in co-operation with the State Colleges of Agriculture, has conducted extensive educational campaigns to demonstrate methods of preventing soil wastes from erosion. Volumes have been written about the millions of tons of good soil that have been washed into the rivers and transported to lower levels and out to the oceans. But erosion still goes on and will go on until each operator of a farm does all that is economically and humanly possible to prevent it. Attention is now turned toward some of the practical methods employed to stop erosion that are within the ability of most farmers to provide.

Keep Rough Land in Grass. Experience has shown that land covered thickly with grass does not erode or erodes but slowly. The more level land will erode but little if kept in grass and legume crops. Very rough land is subject to some sheet erosion and to gully erosion where the surface is cut by wagon wheels or by the hoofs of animals traveling frequently in the same path or trail. The remedy is to minimize the travel over such land and control the travel of livestock on it. Hardy, persistent grasses, such as Kentucky bluegrass, brome grass, or even the troublesome quack grass should be used in the ravines and waterways where the heaviest run-off occurs. A good stand of alfalfa or of alfalfa with mixed grasses may be used to advantage on the less rough portions of the land. The application of manures or commercial fertilizers at times to stimulate vigorous, active growth is advisable. Rotation grazing of pasture land and undergrazing, rather than overgrazing will do much to preserve the grass stand and to prevent erosion. Light-footed animals, such as sheep or goats, will cut the surface less than horses or cattle and should be used on the rough land where good farm economy permits.

Strip Cropping. On most farms a large part of the land must be used for other than pasture crops. Cereal grains, corn, and hay must be provided for winter feeding. Often cultivated crops, such as soybeans, are wanted for feed. Sugar beets or potatoes may fit in as cash-sale crops. On hilly lands these crops, grown in systematic rectangular fields, are likely to lead to gullying and heavy sheet erosion. The modern way to meet the problem of erosion on such farms is to develop systems of strip cropping adapted to the conditions prevailing on each individual farm. The tillable land on such farms is laid out in strips varying in width from six to ten rods. These are laid out on contours along the side of the hills in such a way as to carry the water very gradually to the lower levels. Tillage operations are conducted, following the contours along the side of the hill instead of up and down the hill. Deep furrows may mark the divisions between the strips, serving at the same time to stop the flow of water in direct line down the hill. Where the land will permit, it is possible to lay out strips that are fairly equal in size and adapted to crop rotation purposes. To illustrate the advantages of strip cropping and the possibilities as well, reference is made to Figure 22, with its accompanying explanation of the objectives of strip cropping.

Figure 21. Heavy rainfall draining into a wrongly-placed dead furrow often leads to serious gully erosion.

Strip cropping is also practiced in areas where wind erosion is prevalent to prevent soil drifting. The custom is to provide a dense, tall growing crop to stop the wind from carrying soil particles across the field. Strips of the sorghums, or Sudan grass, or other crop of similar growth habit, sown at intervals of 6 to 12 or 15 rods, will effectively slow down the drifting and prevent serious damage to small-grain crops. Fall-sown rye or other winter grain can be used in some areas to protect spring-sown grains.

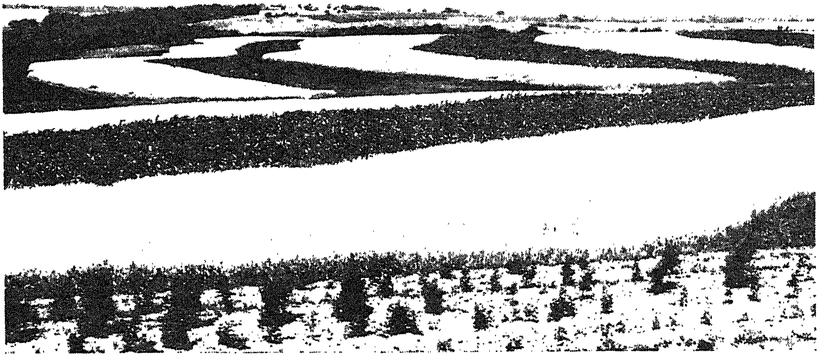

Figure 22. To prevent erosion on slopes and hillsides, the land is cropped in strips 100 to 150 feet in width. These strips follow the contour of the land, providing for gradual flow of water downward along the side of the hill. Grass crops are alternated with grain and cultivated crops to delay the run-off of rainwater.

Terracing. Leveling the land into terraces along the side of a hill is sometimes employed in preparing land for cropping where erosion is troublesome. It is a common practice on the cotton lands of the southeastern states. By means of a road grader or with heavy scrapers the steep banks on the lower side are raised by moving dirt from the upper side. The terraces are laid out on contour lines along the side of the slope and graded to carry the water to lower levels at a rate so slow as to cause but little damage. The banks of the terraces are seeded to grass or other vegetation and left undisturbed by tillage. Crops are then grown on the nearly level land following the contour lines.

A more modern type of terrace, known as the Mangum Terrace is built on a broader base with rounding shoulders and no banks. It is quite as effective in controlling the flow of water as the bank terrace. Its chief advantage lies in the greater ease with which the field can be worked. The absence of high banks and waste land makes it possible to use all the land. The broad round-shouldered terraces permit crossing with implements and offer but little interference to the usual farm operations. This form of terrace is used on the larger farms of the Great Plains and of the Corn Belt.

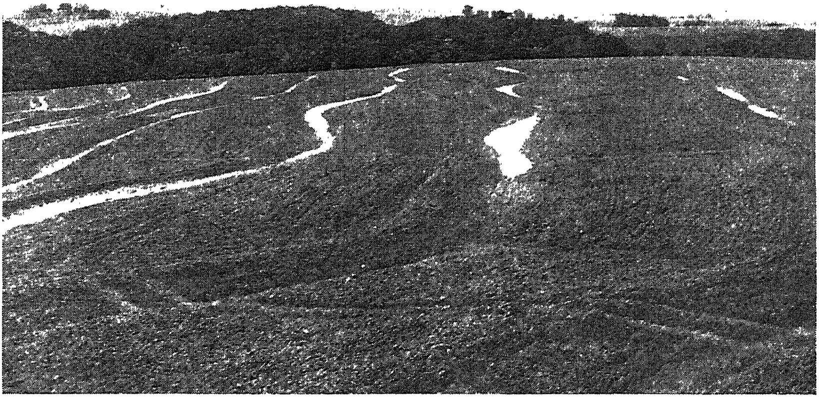

Figure 23. Water stands in the ditches of a field that has been terraced. The terraces delay the run-off and the soil absorbs more of the rainfall, thus increasing the stored moisture for crop production.

Simple conservation practices can often be applied to a field or a farm without extensive planning or great expense. Many farms, however, lie in a watershed. A plan, therefore, must be made for the whole area or district. In such cases the services of a competent engineer should be employed to develop the plan for the district and for each farm in the district. These plans are likely to be complicated and must take many items into consideration.

An illustration of how such a plan can be worked out is given at the end of this chapter. Pupils, with the aid of their teacher, may devise a similar plan for some farm in their own community.

SEED-BED PREPARATION

The initial point in producing a good crop is the seed bed. Some crops do best on an open, mellow seed bed, others on one that is firm and compact. Some seeds should be deeply planted; others germinate best where but lightly covered with soil. Seeds may safely be more deeply planted in a warm, mellow loam soil than in cold, dense clay soil. A farm operator must know not only the soil of his farm, but also the nature of the seed he sows and of the crops to be raised from it. The preparation of the seed bed for each special crop will be treated fully in later chapters of this book. Only the general principles common to all crops will be discussed here.

Plowing the Land. Seed-bed preparation usually begins with plowing the land. The primary reason for plowing is to bring up fresh mellow earth to form the base of a new seed bed. A secondary reason is to bury residues from other crops and incorporate organic matter with the soil. Still another reason is to pulverize the soil and open soil particles to the action of air and sunlight. Incidentally, plowing destroys some forms of insect life detrimental to crops. The action of the air and of the organic matter decaying in the soil bring about chemical reactions which more quickly release and make available the elements of nutrition needed by growing plants.

Whether to plow deep or shallow depends on the nature of the soil to be plowed and of the crop to be grown upon it. As a rule, deep-rooted crops require deeper plowing than shallow-rooted ones. Deep plowing is seldom objectionable except where the surface soil is underlaid with an infertile subsoil or where gravel or other material not suitable for a seed bed would be brought to the surface by it. Deep plowing requires more power than shallow plowing and is consequently somewhat more expensive. For most crops plowing at a medium depth meets all requirements and will prove satisfactory. Plowing at a depth that will permit turning a good furrow and burying the crop residues and trash found on the land is a good rule to follow. Land that has been under cultivation for a long time usually requires deeper plowing than new prairie land or meadow and pasture land when again put under the plow.

When to plow is also a matter of some importance. Again the answer depends on the land and the crop to a large extent. In the Corn Belt and in the greater part of the hay and dairy region, fall plowing is favored in preparing for the cereal crops. For the winter grains it is a necessity. Usually, early fall plowing gives the best results. There are several reasons for this practice. In the first place, turning the furrow slice breaks the capillary connections through which moisture moves to the surface. Early plowing gives time for the soil to settle and again set up capillary action. Fall rains are more readily absorbed into the newly-plowed land and are a factor, too, in again compacting the land and restoring capillary action. On land so plowed only shallow surface tillage is needed in the spring to prepare the seed bed for the crop. Earlier seeding is permitted than where the land must first be plowed. Early seeding, it should be remembered, gives the best yields from most crops.

In areas where rainfall is limited spring plowing is preferred. In that part of the Great Plains area devoted to spring-sown cereals, very little fall plowing is done. The standing stubble from the previous crop serves to hold the snow, which, in melting, supplies moisture to the soil. Spring plowing is followed by immediate seeding on the theory that the moisture from the melting snow and frost will be sufficient to germinate the seed and support the early growth. The soil, open and porous from the plowing, readily absorbs the rainfall when and if it comes, thus supplying moisture to the growing crop. No specific rules can be given to govern the depth or the time to plow. Observance of the principles discussed above, however, will give reasonable insurance for successful crop production.

Other Tillage Operations. Most cereal crops do best on a firm, compact seed bed. Shallow surface tillage is, therefore, the best spring preparation on fall-plowed land. The disk harrow, spring-tooth, and duck-foot cultivator, each serves a useful purpose in loosening the surface, pulverizing the soil, and killing weeds that may have started. Such cultivation does not disturb the soil capillaries nor dry the soil to a harmful degree. Loose, open soils may be firmed by the use of so-called subsurface packers, which pack the lower part of the furrow slice and leave the surface free and loose for covering the seed grain. Packing the soil after the seed is sown improves the moisture conditions, brings the seed in closer contact with the soil, and often hastens germination and growth in a dry, loose seed bed.

Under some conditions the best results are obtained without plowing the land before cropping. In the spring-grain areas, for instance, cereal crops usually follow corn or other cultivated crops in the rotation. On land that has been given clean cultivation the previous year and is free from weeds and trash, preparation of the land may be made by disking to a depth of two to three inches. Double disking may be necessary on corn land.

Such treatment does not disturb the soil moisture so much as plowing and is less expensive. In a series of rotation plots at the Minnesota Experiment Station, where cereals are grown on corn land prepared in this way, yields are equal to or exceed those of the same crops grown on fall or spring-plowed land. Since economy of operation is a large factor in making profits from crop-growing, the good operator will take advantage of all opportunities to reduce expense.

CROP ROTATION CONSERVES THE SOIL

Much can be done to keep the soil in good condition by the establishment of crop rotations suited to the needs of the farm. The continued growth of the same crop on a piece of land over a period of years is likely to lead to bad results. Weeds and plant diseases follow continuous cropping to grain. Erosion and soil depletion are likely to follow continuous use of land for cultivated crops. This result is especially sure where crops are grown on land of uneven contour. Land held in grass continuously will eventually decline in yield unless improved by dressings of manure or commercial fertilizers. These dangers can be greatly lessened by combining the three classes of crops in a well-balanced crop-rotation system.

Crop rotation in common terms means only a proper classification of crops and systematic and regular change in the order of growing them. In arranging the crops in rotation, however, special attention should be given to providing crops which will restore the organic matter in the soil. The legume crops are especially desirable. They not only supply a large amount of leaf and root growth, but the material is highly nitrogenous and improves the soil more than organic matter from other crops.

Farm Crops Classified. Farm crops may be roughly classified for rotation purposes into three groups for the purpose of arranging crop rotation. These are (1) grain crops, (2) grass crops, and (3) cultivated crops.

The grain crops include wheat, oats, barley, flax, rye, and such other cereals as may be grown for mature grain. The roots of all these crops are shallow and feed near the surface. A part of the plants, the stubble, or other crop residue, is returned to the soil. This class of crops may be said to be neutral so far as the destruction of vegetable matter in the soil is concerned.

The grass crops include the true grasses, such as timothy, redtop, bluegrass, brome, orchard grass, rye grass, and others, Included with these grasses for meadow and pasture purposes, many of the legumes are used. The clovers, alfalfa, cowpeas, soybeans and others belonging to the legume family are widely grown. These plants produce a large number of leaves, many of which are broken off and returned to the soil. The roots of the clovers and alfalfa penetrate deeply and aid materially in aerating the soil. The crowns and roots of these plants are large and, when plowed under or allowed to decay in the soil, add considerable organic matter. The grass crops are useful also in keeping down weeds and in encouraging the production of livestock, thus providing manures for the land. The grass crops are particularly useful to increase the organic matter in the soil.

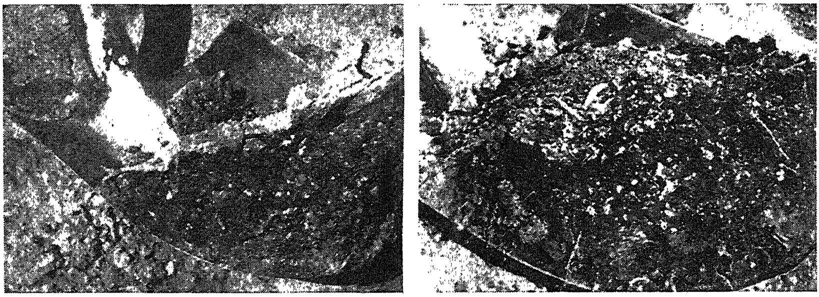

Figure 24. The effect of good crop rotation. Left—Soil from a field where corn has been grown continuously for many years. Note the absence of plant material and the dense, lifeless character of the soil. Right—Soil from a field on which crops are grown in a 5-year rotation. Decaying plant parts may be seen spread through the soil. These are beneficial in liberating plant food elements. They also improve the soil texture.

The cultivated crops, such as corn, cotton, potatoes, and root crops of all kinds, form the third group. While looked upon as soil-building crops and usually grown for the purpose of cleaning the fields of weeds, they are, as a matter of fact, more exhaustive of soil fertility than grain or grass crops. The frequent cultivation in tilling the crops breaks down the organic matter rapidly. The destruction of organic matter renders the soil hard and compact. Air does not enter readily and moisture conditions are not as good as in the soil that contains a large amount of decaying plant matter. Conditions in such a soil are not favorable to bacterial life, which is essential in the formation of plant food. The roots of the cultivated crops supply little or no organic matter and the frequent cultivation hastens the destruction of plant material already in the soil. Land used for tilled crops only usually gets in bad physical condition. Cultivated crops are very destructive of organic matter.

Harmful results will follow continuous production of any of these groups of crops without change. Change of crop within the group should not be considered as crop rotation. A succession of wheat, oats, barley, and flax, is better than growing any one of them continuously. It should be considered only as a change of crop and not a true crop rotation. The growth of timothy and clover, followed by timothy-raising for a number of years would not be rotation, though it is a kind of farming frequently practiced, especially in the eastern states. Any scheme of cropping which provides for a systematic rotation of crops included in the three groups would be a true crop rotation. Grain, either wheat, oats, barley, or some other cereal, followed by grass, such as timothy, or a mixture of some of the grasses with legumes for one or two years and that followed by a cultivated crop, such as corn or potatoes, gives not only a change of crops but a change in classes of crops and is a suggestion of ideal crop rotation.

Rotation of Crops Not Difficult. In arranging rotations it is only necessary that the three groups of crops be included and that the effect of each group upon the soil and upon the crops which are to alternate with it be considered. Grain fields may be divided, sowing wheat on one portion, oats on another, and flax on a third part. The effect of all these crops on the land is practically the same and all may be regarded as grain crops. Frequently only a small amount of one of the cultivated crops will be desired. It is possible to plant a field to corn, potatoes, and mangels or other root crop. Part of the field may be put into corn and the rest occupied by potatoes, sugar beets, or, in the South, cotton. Each of the cultivated crops has approximately the same effect on the land. The cultivated crops, at the same time, offer opportunities for exterminating weeds and cleaning up the land. Part of the grassland can be used for meadow, if desired; the balance, for pasture. Some of it may be in one mixture of grasses for hay-making purposes; the other, in a mixture more suitable for pasture.

The management of a farm under crop rotation becomes more or less automatic. It, therefore, offers fewer perplexing problems than the management of a farm which has irregular fields and no systematic method of cropping. Where two rotation cycles are followed on the same farm, the cropping becomes more flexible than where only one is used. In this case a change of crops can be made within rotations frequently, and it will be possible to meet market fluctuations, seasonal disturbances, or changed labor conditions.

It is important in planning a rotation system that provision be made to have all fields well drained and put in good working condition. Rough or broken land may well be used for permanent pasture. Such land in a rotation field is not only difficult to work but expensive. Short rows, frequent turning, and irregular shape, increase the expense of tillage. So far as possible the fields should be uniform in size and regular in boundaries. There should be a field for each year in the rotation.

The three essential points in successful crop rotation are (1) all fields should be drained and in good condition for tillage, (2) fields should be uniform in size and regular in their boundaries, and (3) there should be one field for each year in the rotation.

WEED CONTROL MEASURES

Weeds have been defined as plants growing out of place or where not wanted. Most plants that are regarded as weeds may serve some useful purpose. Some of the standard crop plants may have the effect of weeds when growing where not wanted. Sweet clover, one of our most useful pasture crops, was long regarded as a weed. It is still so classed when it voluntarily appears in a grain or flax crop. Weeds can be controlled by good farming. Usually, they appear where nothing else is growing.

Someone has said that nature abhors a vacuum and that weeds only fill in the waste places. Proof of this statement may be observed in many places. Ditches, railway cuts, and erosion gullies offer plenty of evidence. Fresh scars made in construction, left to themselves will heal over in time. In most instances they are soon covered over by grass or other useful crop. Often some plant will take possession of the surface. From a slight hold on the land, it spreads out to cover not only the scar but to become established through scattered seeds or extended roots on any spot not already occupied. Thin, overgrazed pasture lands often become weedy. This is because the spots on which the desirable grasses have dried out or killed-off are occupied by yarrow, thistle, burdock, sourdock, or some other persistent pasture weed. Many areas of the Northwest were at one time threatened by the sow thistle. It has been found to yield to good tillage methods and to the full occupation of land with crops of economic value.

Canada thistles, which are troublesome over a large area, can be controlled by keeping the land fully seeded to alfalfa for a period of three or four years.

The remedy for weeds in most instances is to keep the land so fully occupied in growing desirable crops that there is no room for the weeds. Another preventive measure is to avoid sowing weed seeds with grain or new grass seedings. All seed grain should be carefully cleaned and inspected before sowing, and recleaned, if necessary. Only the grades of grass seed which are certified as free from noxious weeds should be purchased. Weed control depends upon good farming. It requires constant watchfulness for the appearance of new and dangerous weeds. Prompt action upon discovery of the first plants will often head off what would become a troublesome pest if left undisturbed.

When land is once infested with weeds, control measures will depend much on the nature of the weed and the type of soil and the climatic conditions under which the infestation occurs. In most instances, eradication of noxious weeds begins with thorough, deep plowing at a time when the roots of the plants have been exhausted in the production of leaves and flowers. A period of black fallow then follows during extremely hot weather and quickly decays the plants. Root growth will start again or new plants will spring up from seeds and the fallow must be continued until growth is reduced to a minimum. Following such preparation with either a dense smother crop or with a crop that permits clean tillage, all but the most persistent weeds can be brought under control.

Specialized attacks on noxious weeds will be needed on farms where firmly established. Spraying with sodium chlorate or other similar chemical may be advisable in some instances. Where large areas are infested it often becomes a matter of township and county co-operation to control the weeds.

Those troubled with weeds beyond their control should consult the nearest county agent or the extension service of their agricultural college.

TIMING THE OPERATIONS

Emphasis has already been placed on the importance of correct timing for all farm operations. Additional emphasis may well be given in connection with crop production. A statement has previously been made that fall plowing is desirable for the production of small grain crops. That, however, depends on the farm and its location. Only experience can determine for each farm whether spring or fall-plowing is preferable. Once determined, however, the practice should be followed as closely as possible. Whether to disk or to plow depends on the soil, on the climatic conditions of the region, and the nature of the crop to be grown. It is important, however, that whatever the operation it be performed at a time which will require the least power and bring the best returns in results. The important thing in either plowing or disking is to put the seed bed in good tilth and to provide the best moisture conditions in the soil to be cropped.

In all farm operations and in all locations there is a best time and a best way to perform each one. It is impossible to anticipate the operations that are to be required by individual farms. That point can best be determined by the one who is to operate the farm. The point to make here is that the habits of the plants and the nature of the soil be known and the tillage and production operations be so timed as to give the highest returns for the least possible expenditure of materials and human energy.

Three Rules to Follow. There are three good rules to follow in making cropping plans: The first is to choose crops well adapted to the soil and climate in which the farm is located. So far as possible the nature of each crop should be given consideration in establishing the cropping system for the farm. The second is to grow crops that are suited to the needs of the family and the livestock or for which there are favorable market outlets. The third is, so far as possible, to devote the farm to the production of crops that return high values. Recognition of these principles in crop production may mean the difference between profitable and unprofitable operation.

ILLUSTRATION AND DISCUSSION OF A COMPREHENSIVE SOIL CONSERVATION PROGRAM FOR A NORTHERN ILLINOIS FARM[1]

This 153-acre farm is located in northern Illinois, where general livestock farming is assuming increased importance. The soils of this farm, except for five acres, are divided almost equally between two types, Clinton silt loam and Lindley silt loam. Both soil types are brownish yellow-gray silt loams developed on limestone and glacial till, respectively, and the original depth of the A horizon was approximately 10 to 16 inches in both cases. The slopes are undulating to rolling and vary from 2 to 12 per cent. Considerable sheet erosion has taken place; on the majority of the land at least 25 to 50 per cent of the original topsoil layers have been washed away (class 3 erosion). On part of the Clinton

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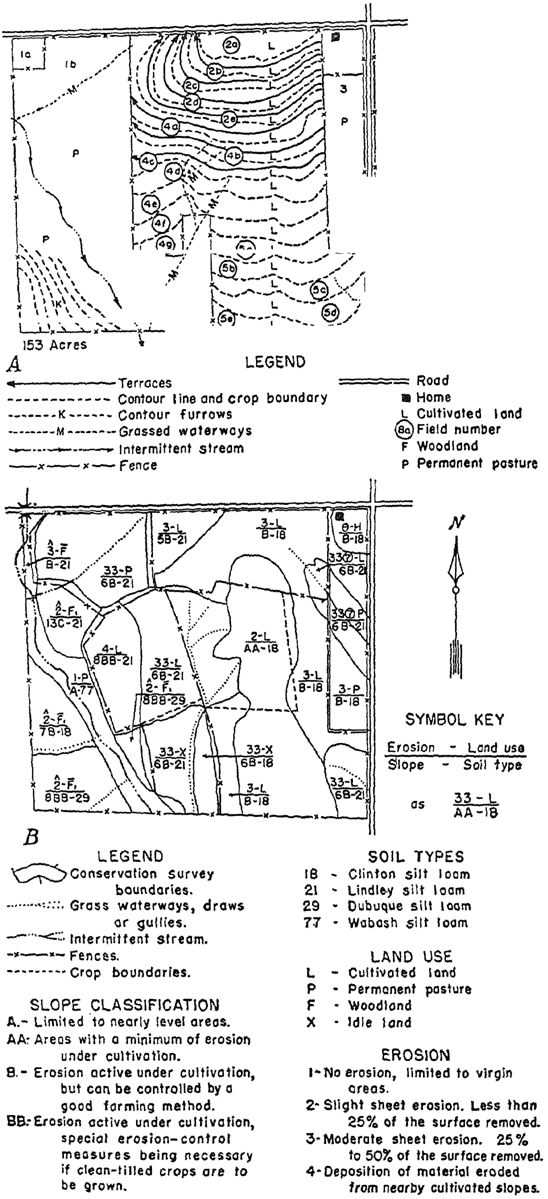
[1] From *Yearbook,* United States Department of Agriculture, 1938. P. 674-76.


153 Acres
A
LEGEND
Terraces
Contour line and crop boundary
K Contour furrows
M Grassed waterways
Intermittent stream
Fence
Road
Home
L Cultivated land
(8a) Field number
F Woodland
P Permanent pasture
B
N
SYMBOL KEY
Erosion - Land use
Slope - Soil type
as 33 - L / AA - 18
LEGEND
Conservation survey boundaries.
Grass waterways, draws or gullies.
Intermittent stream.
Fences.
Crop boundaries.
SLOPE CLASSIFICATION
A.- Limited to nearly level areas.
AA: Areas with a minimum of erosion under cultivation.
B.- Erosion active under cultivation, but can be controlled by a good farming method.
BB: Erosion active under cultivation, special erosion-control measures being necessary if clean-tilled crops are to be grown.
SOIL TYPES
18 - Clinton silt loam
21 - Lindley silt loam
29 - Dubuque silt loam
77 - Wabash silt loam
LAND USE
L - Cultivated land
P - Permanent pasture
F - Woodland
X - Idle land
EROSION
1- No erosion, limited to virgin areas.
2- Slight sheet erosion. Less than 25% of the surface removed.
3- Moderate sheet erosion. 25% to 50% of the surface removed.
4- Deposition of material eroded from nearby cultivated slopes.

A. Land-use map of the representative Corn Belt farm, illustrating erosion-control planning in the Midwest. B. Conservation survey and soil map of the farm.

silt loam area, erosion has not been so severe, falling within class 2 (not more than 25 per cent of the original top layers of soil removed).

The erosion-control program outlined for this farm calls for approximately 55 per cent of the total land area to be in crops. This percentage of cropland is somewhat lower than is usual in some other parts of Illinois, in Iowa, and in Missouri. The plan, however, establishes an immediate program and one that will give assurance of the future fertility maintenance of comparable farms with gently rolling to undulating topography, erodible soils, and some appreciable soil losses to date.

In addition to serving in the capacity of erosion-control vegetation, many matured woody plants have definite importance in the farm economy. Field 1a (2 acres) will be retired from pasture to woodland and managed for future woodland purposes. This arrangement will provide adequate treatment for this small area, which has a relatively steep slope and has been severely damaged by erosion. A properly managed woodland will produce fence posts, lumber for repair of buildings, and other timber products, and will serve as a habitat for wildlife.

Forty-two rods of woven wire, 126 rods of barbed wire, and 50 fence posts will be used for construction of the fence necessary to protect this area from grazing. About 2,500 mixed hardwood seedlings will be set out in this 2-acre area.

RETIREMENT OF ERODED CROPLAND TO PERMANENT PASTURE

It is desirable in many cases to retire certain croplands that have eroded to an appreciable degree. Field 1b (57 acres) is designated for permanent pasture. Approximately 17 acres of this field will be retired from crops and seeded with a pasture-grass mixture. Oats will be used as the nurse crop. The old boundary fences will not be removed until the new pasture is ready for use. The following commodities and materials are necessary for use on this field: 50 bushels of oats (nurse crop), 425 pounds of mixed grass seed, 75 tons of agricultural limestone (to be used on new pasture areas), 300 fence posts, 220 rods of woven-wire fencing, and 660 rods of barbed wire. Special attention will be given to the development of a good grass waterway at the north end of this pasture, where water comes from fields 2e and 4a and from the adjoining road ditch.

Seven acres of this pasture, in the southwest part, will be contour furrowed to aid in holding more moisture, to obstruct surface run-off, and to reduce soil losses from erosion.

Pasture Improvement Where Overgrazed. Even permanent pastures are not free from erosion, especially where they have been improperly handled. Field 3 (8 acres) will continue in permanent pasture. This area has been overgrazed in the past and damaged somewhat by erosion along a draw in the middle. An application of 25 tons of agricultural limestone will be applied to aid in producing a heavier sod and to increase the carrying capacity of the pasture. Four tons of ground rock phosphate will also be applied to aid in rejuvenation of the pasture grasses.

STRIP CROPPING AND TERRACES

To Break the Slope. Effective erosion-control practices and devices can be used that will not interfere with usual farm operations. Fields 2a (3.6 acres), 2b (3.9 acres), 2c (4 acres), 2d (4.2 acres), and 2e (4.3 acres) will be farmed on the contour in strips, with a predominant 5-year rotation of corn, oats (hay seeding), hay, corn, and oats (sweet clover seeding). The strips will be 100 to 120 feet wide, and the rotation will be followed for each strip, so that no two adjacent strips have corn on them the same year.

The longer rotation established for this field will build up soil fertility, and the strip-cropping practices, with alternate bands of close-growing and clean-tilled crops, will retard water run-off and decrease soil loss. Soil tests indicate that 60 tons of agricultural limestone will be needed for the field. Lime will be applied on each strip before seeding for hay.

A new fence will be constructed along the north side of this field to permit easy access to the pasture, field 1b, for which 130 fence posts, 96 rods of woven wire, and 288 rods of barbed wire will be needed.

Four broad-base Mangum terraces will be constructed in this field, in strips 2b, 2c, 2d, and 2e. They will empty into a grassed outlet which will be seeded along the west end of the land bordering the north side of the field. These terraces will reduce run-off and assist in controlling sheet erosion.

To Aid in Gully Control. In many instances, practices and devices designed for erosion control on a specific field will assist in soil conservation farther down the slope. Fields 4a (6.5 acres), 4b (6.8 acres), 4c (7 acres), 4d (6.9 acres), 4e (7.3 acres), 4f (6.3 acres), and 4g (1.9 acres) will be operated on the contour in strips approximately 110 to 140 feet wide. Except for strip 4g, which is irregular because of the draw which will be fenced out and included in the pasture field, the cropping pattern will predominately follow a 6-year rotation of corn, corn, oats, and 3 years of alfalfa. This field is nearly level, and less than 25 per cent of the topsoil has been removed; but the rotation with 2 successive years of corn following 3 years of alfalfa can be followed without danger of speeding erosion. The soil type on this field is predominantly Clinton silt loam, which, although subject to severe erosion when clean-tilled repeatedly, can be maintained from both a structural and fertility standpoint by following a good rotation, which will help keep up the organic content of the soil, and by utilizing practices which will prevent rapid water run-off.

Three broad base Mangum terraces will be constructed on the upper part of this field in strips 4a, 4b, and 4c. These terraces will empty into the pasture field 1b. They will be constructed after the new seeding of pasture grass is well established on the east side of field 1b, where some cropland is to be retired. This disposal of excess run-off will reduce the quantity of water going through the draw and potential gully which enters field 1b at the east end of strip 4g. Vegetation, therefore, will be sufficient protection for the soil in this draw, and no structural work will be necessary.

WIDER STRIPS AND SHORTER ROTATIONS ON MORE NEARLY LEVEL AREAS

Erosion control recommendations are made for different fields according to the seriousness of the problem involved. If erosion is not very serious, then the practices to be followed are not so rigid. Fields 5a (2.6 acres), 5b (4.4 acres), 5d (4.8 acres), and 5e (4.4 acres) will be worked as contour strips approximately 120 to 150 feet in width. Fourteen tons of agricultural limestone will be necessary on strips 5b and 5d, the first year of the rotation, since they are to be seeded to clover. A similar application will be made on each of the other strips before seeding them to clover later in the rotation. The rotation on this field may be shorter and include a higher percentage of clean-tilled crops, since it is almost level and past treatment has left it in a relatively high state of fertility. The rotation will be corn, oats (sweet clover), corn, oats, and hay.

GENERAL COMMENT

The established crop rotations will permit approximately 37 per cent of the cropland to be in corn each year, 33 per cent in grain, and 30 per cent in hay. For some of the strips directly affected by terraces, it may be possible to use a shorter rotation and increase the clean-tilled crops somewhat. With more emphasis on soil fertility maintenance and the enlargement of livestock enterprises, it is improbable that this farmer would need to reduce his proportion of hay and grains. From a long-time point of view, prices, regional shifts in emphasis on different enterprises, and other economic factors will guide him in amending his program.

Suggestive Questions

1. What provision is made on your home farm for maintaining the productive power of the soil?
2. Is drainage needed to insure good cropping conditions?
3. What evidence of erosion can you see in your locality?
4. What is being done to control it?
5. What reasons can you give for plowing the land?
6. Name some of the benefits to be gained by crop rotation?

Suggestive Activities

1. Make a list of the kinds of crops grown in the legally described section in which your farm is located.
2. Learn how many rods of ditch and tile drainage there are in the section.
3. Determine the proportion of grassland to cropland in the section and compare your farm with the result.
4. Organize a crop rotation plan for your project farm.
5. Make a survey of the noxious weeds in the section in which your farm is located.

CHAPTER X

THE PLACE OF LIVESTOCK IN FARM OPERATION

Animals of one kind or another are found on nearly every farm. It is reasonable to suppose that each class of animal raised fulfills some function useful to the operator. In some cases the function is to furnish amusement and entertainment for the family. In others it is to contribute directly to the farm income. Dogs and cats are sometimes kept as playmates for the children of the family. Dogs are useful also in assisting with the care of livestock or in guarding it. Hunting dogs are much used in recreational excursions through the fields, forests, and swamps for game birds and animals. No direct income is expected or earned from the use of such animals.

Horses or mules are kept on most farms for their usefulness in furnishing power for farm operations. Horses are kept by some farmers, however, and by many others who are not farmers, for the pleasure gained from driving, riding, polo playing, or hunting. For these latter functions no direct income is returned. One may be justified in keeping dogs for hunting and horses for riding where the expense can be afforded without limiting the funds needed for family living expenses. In such cases the operator may truly be said to be keeping the animals, that is, contributing to their support without expectation of financial reward. As sources of power, for which they are used on most farms, horses and mules contribute directly to the farm income when wisely used. In such cases they may be said to be keeping the farmer. That is, they are contributing to the support of the farmer and his family. To add net income to the farm operator is the major reason for producing livestock. The income arises from different sources with the various classes of livestock, but the objective is the same, support for the farm operator and his family.

That livestock produced is an important enterprise in farming is indicated by the fact that nearly two thirds of the income from the farms of the United States is from the sale of livestock and livestock products. A careful study of the problem of making profits from livestock production will be of value in gaining an understanding of the place of livestock in the operation of a farm.

HOW LIVESTOCK EARNS INCOME FOR THE FARMER

As previously has been pointed out, each class of animals must perform some service of economic value or yield products that are usable by the farm family or that have ready sale value. This fitting of livestock into the farm program may be accomplished in a variety of ways.

The chief functions of livestock in farming are (1) to convert feeds into foods; (2) to condense bulky feeds into more concentrated form for shipment and sale; (3) to convert into usable or salable form materials that otherwise would be wasted; (4) to more fully employ the resources of the farm; (5) to increase the frequency of sales and of income; (6) to provide a variety of foods for the farm family; and (7) to help in maintaining soil fertility. The manner in which these functions are performed will be clarified in the discussion following.

Converting Feeds into Foods. Farming is based on crop production. The soil and climatic conditions of an area or a locality determine what crops can be raised safely and with satisfactory yields and results. Since farm animals live almost entirely on plant life, the kind and quantity of crops that can be grown in an area or on a farm determines the classes of animals that can be economically produced in that environment. Some crops are produced as human-food crops, others as feed for animals. Potatoes, vegetables, fruits, and, to a large extent, wheat and rice are examples of food crops that can be used by man without conversion into other forms by animals.

Grass and forage crops can not be used in a natural form as human food. They must first be converted into milk or meat or some other form, such as wool or leather, before they are useful to mankind. Corn and cereal grains can be used directly as human foods, but the nutrients contained in them are much more acceptable when converted into milk and meat.

Only about one fifth of the land surface of the United States is used in crop production. The balance is in grass, forest, and waste lands, and land used for social purposes. Of the land used for the production of crops only a small portion is used for the production of food crops. The balance is used for the production of rank-growing forage crops and coarse grains used in the support of animals. These feed crops are converted into foods and other materials usable by dairy cows, beef cattle, swine, and sheep. They are also used in the support of horses, which are generally kept for the purpose of furnishing power.

To Convert Feed into Concentrated Form. Bulky feeds are often grown at long distances from central or terminal markets. Transportation charges on such products are high in proportion to their sale value. It is important that these products be condensed into more concentrated form as a means of getting them to the market at less expense. Converted into meat by feeding to animals, the value is expressed in salable meat products which can be transported at less cost and return greater value. Converted into butterfat, cheese, or some other form of dairy product, the net energy of the feed crops can be transported economically for long distances. Other examples might be given, but these are sufficient to illustrate the value of livestock for this purpose.

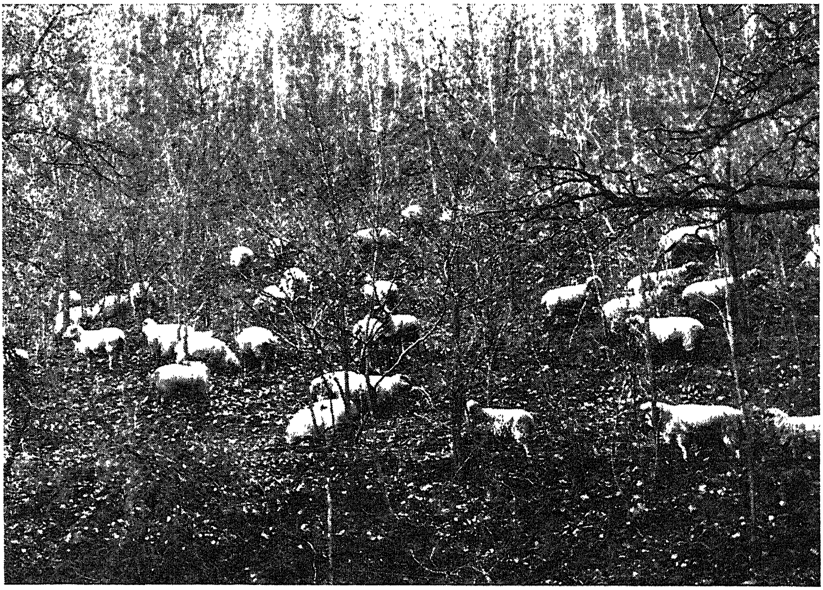


Figure 25. A flock of sheep converting unsalable grass, weeds, and brush into edible meat and salable wool which find ready use or sale and add to the income from the farm.

Livestock Converts Unsalable into Salable Products. Approximately one third of the land surface in the United States is in pasture crops, that is, grasses of one kind or another. Grass is the natural feed for livestock. There is no market for a grass, as such. It has use and value only when pastured by productive animals or when grown to maturity and converted into hay, which is used as livestock feed. A large part of the cropland is in rank-growing forage crops. These crops are converted into hay, cured forage, or some form of fodder. The only outlets for such products are through the medium of some class of animals that can convert them into usable products. Following the removal of grain crops, volunteer growth, which has feed value, will often spring up, but can be utilized only if there is livestock to pasture it off. It can be left to stand and be returned to the soil as organic matter when the land is plowed; but, in that case, it yields no income to the farmer. If pastured off by dairy cows or sheep, it will return income to the farmer and the land will not be seriously depleted by the animals' pasturing upon it. Aftermath grows also in the meadows after the hay crop is removed. This material also would be waste or returned to the soil, were it not used by some class of animals that can convert it into a form usable for human beings.

By-products of the grain fields have little direct value. Straw from the grain crops, corn stover left after the corn is husked, screenings from the grains to be sold or from seed grain are examples of these by-products. There are by-products of the flour mills and of factories also from which economic returns can be secured only through their use as feed for livestock. Bran and shorts from the flour mills, linseed-oil cake and soybean cake from the oil mills, cottonseed meal from the cotton mills are familiar examples of these by-products. They are all high in nitrogenous content and are useful complements to the coarse grains in forming suitable feeding rations for dairy cows, hogs, or other animals. Most of these would be waste products, were animals not able to convert them into human-food products.

Corn, oats, barley, the sorghum grains, and other coarse feeds are usually salable but at such low values as to make them unprofitable crops. In the long run these crops will bring larger returns to the farmer if marketed through some class of animals. It is here that the farm operator must exercise good judgment. When grain values are high and prices for animals are low, such grains may often be fed at an economic loss. At other times, when the relation of livestock prices to feed prices is favorable, they may be fed with satisfactory economic results. Only by watching the market closely and by efficient feeding can profits be made from feeding readily salable grains to livestock. It must be remembered, however, that livestock is the natural outlet and a most profitable one in most instances. While there are regions that raise coarse grains for cash sale regularly, these grains ordinarily are transported only short distances to where they may be fed to livestock.

On many farms there is some form of waste land. It may be rough, stony, side hills that are free from trees or other growth, but on which grass grows readily. Land that is untillable because of stumps, stones, or other impediments may produce good grass pasture. Low land, too wet to work satisfactorily, may often be made to yield a return to the farm by putting it into reed canary grass, redtop, or other crops adapted to it and it can be made into hay or pastured. No returns could be made from such land except through the medium of livestock.

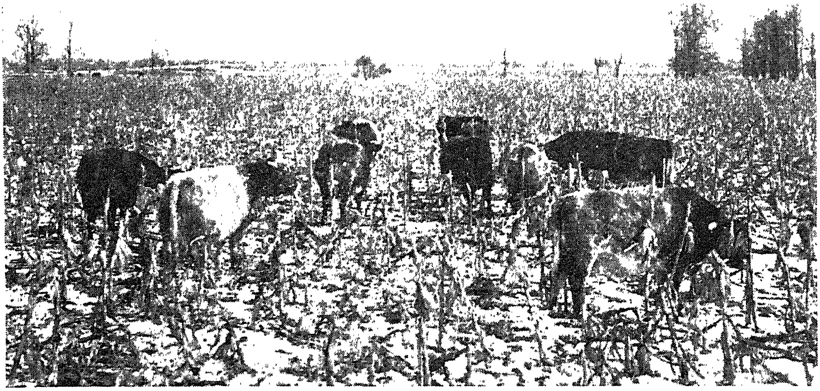


Figure 26. Cattle feeding on stalks left after the corn crop has been husked. Feed that would otherwise go unused is thus converted into salable products.

Profits from livestock-growing are most consistently made from the use of low-cost feeds. The foundation for such production lies in good grass and legume pastures. These furnish the natural and lowest-cost feed for the classes of animals known as ruminants, that is, cattle and sheep. It is also a satisfactory feed for growing colts or for horses that are not employed in heavy work. Good pastures supported by ample supplies of high-quality cured forage lay the groundwork for economic livestock production. For finishing meat animals for the market low-cost coarse grain crops are essential. These, supported by products of the mills and balanced with a minimum quantity of the high-cost concentrates, offer the most certain avenue for profits from livestock-raising. It should be borne in mind that the one who feeds salable grain, such as wheat, corn, and oats, to livestock is in competition with those who raise their stock on grass, corn fodder, and other cheap waste products of the farm. To compete successfully, the quality of the product must be higher or more must be produced for the same value in feed. For this reason those who feed large numbers of animals on high-priced grain usually raise purebred stock, which has a breeding value as well as a market value for the products produced. If a high-cost ration is fed, a high-valued product must be returned or loss will be experienced.

Livestock More Fully Employs Resources of the Farm. Profits from farming are made by growing usable and salable crops and by producing or making commodities that have market values. The more of these commodities that can be produced on a given farm, the greater the net returns become, if good management is used. For good returns the farm should be so operated as to have a well-rounded program of production that will utilize not only all the land but all the other resources of the farm and give productive employment to all available labor. On most crop farms some land can not be used for tilled crops. Livestock can be pastured on it, thus utilizing this resource. Crop-farming seldom gives full-time employment the year around for the labor of the farmer and his family or for such help as he may employ. There is time to spare between seedtime and harvest. Productive employment on a farm devoted to raising crops is seldom found during the winter months. The children of the family must be supported whether employed or not, but there is little employment for them during spare time in the summer or during the winter months. Should the farm be supplied with a reasonable number of dairy cows or with beef cattle and hogs or some other form of livestock, there would be employment for the available labor during the times when it would not be needed to care for the crops.

Livestock may increase the volume of business done by the farm in many other ways. It does not follow that livestock added to a crop farm will always increase the income from the farm. Much depends on the efficiency of the management. It is estimated that the feed cost of dairy cows and poultry is about 50 per cent of the total cost, the other 50 per cent is made up in labor, equipment, and overhead cost. In hog-raising and in sheep-raising, on the other hand, feed costs run 75 per cent to 85 per cent of the total cost, with labor forming a much smaller proportion. The kind of livestock raised, therefore, should be fitted to the type of labor available and to the number of people that the farm supports, whether employed or not.

The full utilization of the resources and a large volume of business is considered desirable, because it reduces the fixed overhead costs. Interest charges, taxes on real estate, and other fixed expenses will be but little larger for the farmer who keeps livestock. More complete use of the buildings and more constant employment of labor on productive livestock enterprises during spare hours will increase the income from the buildings and equipment and the net income to the farm.

Usually it is desirable to keep more than one class of animals, because it is not otherwise possible to utilize all the resources. Dairy cows and hogs will go well together because the hogs supplement the cows in utilizing the resources of the farm. Where butterfat is sold skimmed milk, which may be used for hog or poultry feed, becomes available. The common experience, therefore, is to find that both hogs and poultry are kept in some numbers on farms that specialize in dairying. Dairy cows require much labor. Hogs add but little to the labor load. They are, therefore, said not to compete for the labor but to supplement each other in the provision of salable products and feed supplies. Dairy cows make the cheapest products on coarse feeds and forage, with a limited quantity of concentrates. Swine, on the other hand, use but little of the coarse feeds and forage and live largely on concentrates. The dairy cows utilize the pastures and coarse feeds. Swine utilize the skimmed milk and the grain by-products in the production of salable food products. The use of both on a farm not only increases the volume of the business, but under good management gives larger net returns.

Fattening cattle, likewise, are adapted to the use of pasture lands and coarse forage crops. When supplemented by swine and sheep, they offer full year-round employment, with the swine living, to a large extent, on the waste products from the feed bunks and feed yards. In supplementing cattle, sheep eat the coarser particles left in the feed racks and act as scavengers in cleaning up what would otherwise be waste material.

Increase the Frequency of Sales and Income. In most kinds of crop production, there is only one harvest annually. The income is likely, therefore, to be concentrated into a short period or a single sale. That usually means a feast and a famine for the farm family. Income spread out through the year is more likely to lead to reasonable expenditures and better living. With some forms of livestock, such as beef cattle, there may not be much improvement in the continuity of income throughout the year. With other classes of livestock, such as dairy cows or poultry, income is returned at frequent periods and regularly. While crops are seasonal in production and sales dates may be infrequent, livestock operations can be planned so as to bring sales dates reasonably close together. Some farmers have made it their aim to have a sales day at least once a week. Others are satisfied with a monthly pay day. This plan can easily be accomplished where the livestock program is well planned and the farm organized to support the plans for livestock production. Emphasis may be given to one class of livestock when price prospects are favorable for the production from that class or they may be minimized, when unfavorable. In the long run, however, it pays best to organize definitely for the production of certain kinds of livestock that offer reasonably frequent pay days and stick to that type until some better plan of production can be devised.

To Provide a Variety of Foods for the Farm Family. Farm families, living on farms that produce crops only, are likely to have a limited diet, at least for a good part of the year. The addition of a few cows, some poultry, and at least swine enough to supply the meat needed by the family, will give not only variety to the diet, but will supply nutrients not readily available in the crops produced. Even though a good garden supplements the crop farm, some of the animal products, such as milk, butterfat, and nitrogenous substances of the meats are essential to health and greatly improve the living conditions of the family. Surplus products, arising from these enterprises, if any, will find ready sale in near-by markets at some price. Though the price will not be great, it will supplement to some extent the income of the farm family, because made by labor that does not imply additional cost.

To Help Maintain Soil Fertility. The opinion commonly prevails that livestock-raising helps to maintain the fertility of the soil. This opinion is true only under certain conditions. It is estimated that an oats crop yielding 50 bushels an acre will require from the soil 50 pounds of nitrogen, 18 pounds of phosphoric acid, and 45 pounds of potash, beside small quantities of several other elements. If the grain is sold and the straw is burned, the entire quantity may be truly said to be removed from the soil. If the grain is fed to cows, the milk and butterfat sold, and the straw used for bedding, but the manure allowed to remain in the yard or barn, just as much fertility is removed from the land as though the crop was sold and the straw burned. If, however, in feeding the grain and using the straw for feeding, care is taken to save all the manure and later to return it to the fields from which the crop came, there would be little loss of fertility. It is very difficult to prevent some loss through decomposition, evaporation, or leaching. There may also be more or fewer losses from mechanical sources. The losses will depend upon the methods employed in getting the manure to the field. The loss from all these sources varies from 40 to 60 per cent. About three fourths of the fertility contained in the feed is removed in the manure as it comes from the animal. This may all be returned to the field where leaching and mechanical losses are prevented. On most farms nearly one half of the fertilizing value contained in the feed is lost before the manure is returned to the field.

The animals through which feeds pass add nothing to the fertilizing qualities of the manure. The crops returned directly to the field upon which they grow would quite as well maintain the fertility of the soil. In the case of the growth of certain of the crops, such as clover and alfalfa, the fertility may even be increased through the addition of nitrogen which these plants have the power to gather from the air in the soil. That use of the crops, however, would not be an economic one.

Mastication and digestion of the foodstuffs by animals render available more quickly the fertilizing elements of the plants. This readier availability of the elements accounts for the belief that the process of mastication and digestion has added to the fertilizing value of the feed materials. Animal manures, without question, are one of the best possible sources for maintaining soil fertility, but the farmer should recognize the fact that, to get their full value, he must prevent all mechanical and chemical losses and that the manures must be distributed evenly over the farm and incorporated with the soil.

The best way of conserving all the fertilizing elements of the manure is to haul it from the barns as made directly to the fields and incorporate it at once with the soil. When decomposition sets in or leaching occurs under such circumstances, the soil absorbs the fertilizing elements and retains them until needed by the growing crops. The largest possible quantity of fertility is thus retained in the land.

Besides saving the fertilizing elements of the manure, this method of application has the added advantage of economizing labor. It requires no more time to load the manure directly into a spreader or wagon than to wheel it out of the barn and dump it into a pile which must later be loaded and hauled to the field. Less labor is required, also, than where the manure is loaded into a wagon and hauled to a compost heap from which it must again be loaded and taken to the field.

One must recognize the fact that it is not possible on many farms to haul manure from the barn directly to the field throughout the year. Growing crops on the land to which the manure should be applied often interfere during the crop-growing season. Often other work, demanding the available labor, prevents daily removal of the manure to the fields. In the North, snow and cold weather make it difficult to operate a spreader in the wintertime. Whenever land is available, however, upon which to spread the manure, or when weather will permit, it should be taken directly from the barns and yards to the fields and spread evenly and rather thinly as hauled. In few instances is an application of more than ten or twelve tons an acre advisable. If heavier application is made, more nutritive elements will be liberated than can be used by the plants. They will be carried out of reach of the plants by leaching. Thinner applications, more frequently applied, will economize the fertility elements in the manure and make larger quantities available for crop production.

It is quite common practice to haul manure to the fields and unload in half-load to load piles. It is allowed to stand in these piles during the winter and is then spread by hand in the spring. Nearly as much loss occurs from decomposition and leaching when manure is handled in this manner as when it is allowed to lie in piles under the eaves of the barn. The labor of applying is also increased and the fertilizing value is not uniformly distributed. When manure can not be hauled directly to the fields, it should be spread out evenly over a level yard and the stock allowed to run over it, tramping it firmly. If the yard can have a concrete bottom, there will be less loss from leaching than where it lies on open ground. In many localities such floors are built or concrete pits constructed in which the manures are accumulated until they can be hauled to the field. Such methods undoubtedly conserve the fertility elements, but they are expensive to build and increase the cost of handling the manure.

LIVESTOCK MUST BE ADAPTED TO THE FARM

The kind of livestock to keep on any individual farm depends upon several factors. It has yet to be proven that one kind of livestock is more profitable than another, when grown under favorable conditions. Profits are made from growing each class of livestock, but often one class is better adapted to a certain farm than another.

Size of Farm a Factor. The size of the farm operated is a large factor in determining what livestock should be kept. As a rule, small animals go with small farms. A five or ten-acre farm may be ample for the production of vegetables. On such farms little, if any, stock can be expected to pay profits. Usually, the animals kept on such farms are only those that supply power or that provide products for the farm family. A twenty-acre farm may be well adapted to poultry-raising and would do fairly well for the production of a small number of pigs or sheep, if well farmed. It would not be adapted to dairying, beef-cattle raising, or the production of horses. These animals require large quantities of pasturage, forage, and coarse feeds, which could not be supplied from the farm. The animals would have to be kept closely confined, thus requiring much labor and adding to the expense. Studies show that it requires 2½ to 3 acres of good land to support a cow. This much land should supply summer grazing, winter forage, and the principal part of the grain feeds required. On a farm of 160 acres not more than 50 cows could well be kept. That would be stocking the farm at 3 acres per animal unit, provided no other livestock was kept. Few farms are so intensively stocked. A combination of 30 cows with 40 to 50 head of hogs would spread the labor load, more fully utilize the resources of the farm, and in all probability return greater profits.

Market Demands Must Be Considered. Market demands and shipping facilities must also be considered in deciding what kind of stock to keep. Livestock products are concentrated and easily shipped, if transportation is rapid and frequent. Milk and cream are somewhat perishable, however, and must be put on the market promptly and frequently. Live animals may be shipped long distances, but are subject to heavy shrinkage and loss by accident or death. Freight charges and care while on the road must also be covered. Short distances are more favorable for livestock shipment. Grain and other imperishable products may more safely be shipped long distances.

Available Capital May Determine. The amount of capital available for investment often determines the kind of livestock that can be kept. A farm can be more cheaply stocked with small animals than with large ones. The length of time which must elapse before returns can be made from the animals should also be considered. In this respect the advantage lies with the cows, as the milk and butterfat are immediately available for sale. With sheep, either the lamb or the wool crop is likely to mature within six months from the time of purchase. The return from hogs can rarely be realized short of six or eight months. In horse-raising, the colt crop is not mature for market inside of three years, though younger colts are sold. Better prices can be secured, however, when they are over, rather than under, three years of age.

THE KEY TO PROFITABLE LIVESTOCK PRODUCTION

As has been pointed out repeatedly, the objective in keeping livestock of any kind is to add to the net income from the farm. This statement must be interpreted to mean net income over a long period of years. Few operators are wise enough or adept enough to go into or out of livestock suddenly without incurring too great expense or meeting heavy losses. One should engage in livestock-raising only when satisfied that the conditions prevailing in the area occupied are favorable for that type of business.

It may be well to summarize in a brief way some of the factors leading to profitable livestock production.

Ample Feed Supplies. The foundation of profitable livestock production lies in the grass crops. These are best offered in the way of good pastures on the arable lands and well-managed native grasses on the nontillable and range lands. Open pastures and ranges offer the most sanitary conditions for the production of livestock. Labor requirements while the animals are on grass are also reduced to the minimum. The rapid gains and high production by animals on grass and the low labor expense of caring for them at such times offer the best margin of profit.

It is important that the farm or the range supply in adequate quantities the cured forage and rough feeds needed to care for stock through the season of the year when pasture lands are not available. The more nearly such forages can supply the nutrients offered under pasture conditions the better the production from the animals. Good quality alfalfa, soybean or other legume hay will carry some classes of livestock satisfactorily without grain supplement. If satisfactory growth is made or weight and condition maintained on such feed, the cost is much less than where grain must be fed.

Where heavy production is expected from the animals or where rapid gains are desired, grain supplements of one kind or another must be provided. The nature of these supplements will depend on the work to be done and the quality of the other feeds supplied. For high production, it is essential that the grain supplements be of good quality and palatable. Minimum rather than maximum quantities are likely to pay the highest returns. Heavy feeding of grain concentrates, however, is sometimes advisable in rapidly finishing either beef cattle or hogs. Concentrates are sometimes justified also in rations for dairy cows that are forced to high production. Unless one is able to supply ample feed, it is unwise to undertake livestock ventures. No money is to be made from poorly-fed livestock.

Good Management and Care. The well-doing of animals depends upon bodily comfort. To supply conditions which will permit such comfort is one of the many problems of the farm operator. Pretentious buildings, rigid stanchions, and poorly-ventilated quarters do not mean comfort to the animals. One of the reasons why livestock does best on pastures and open ranges is because they are free to adapt themselves to conditions and gain the greatest possible bodily comfort. Under such conditions they are contented and at ease, which is more than can be said of much of the livestock forced to live in barns and yards. Comfortable quarters in a moderate barn may give much better results than uncomfortable quarters in a pretentious barn. Dairy cows, confined for a large part of the time during the winter in stanchions on hard cement floors, enjoy a period of relaxation in a sunny shed or even in an outdoor yard on a warm day. Those who allow their cows the privileges of an exercising shed during the winter months get better production records than those who permit no such relaxation.

The timely feeding, the provision of water at will, and attention to all matters that will give desirable bodily comfort and contentment are the essentials of good management. With these, the quarters must be kept in good sanitary condition whether the animals are in pastures, yards, or barns. Good health, good quarters, and ample feed are the key to profitable animal production.

Suggestive Questions

1. How many kinds of livestock are raised on your home farm?
2. For what purpose is each kind used?
3. What are the chief functions of livestock in farming?
4. Why is milk valued so highly as a human food?
5. What animal food products are most commonly used in your home?
6. Why are good pastures so important in profitable cattle raising?

Suggestive Activities

1. Check the sales records in your account book and calculate the gross income from each kind of livestock raised.
2. Estimate the time between birth and usual sale age for each of the kinds of livestock kept.
3. Make a comparison of the amount of man labor spent daily in June and in January on each kind of animal kept.
4. Compare the amount of labor spent on livestock during the year on your farm with that spent on crops.

CHAPTER XI

PRODUCTION OF CEREAL CROPS

Used for both human food and feed for livestock, the cereals as a group are very important to agriculture. The botanist defines a cereal as a grass grown for its edible seed. He means that the plants belong to the Grass, or Gramineae, Family, and the fruits produced are seeds which may be eaten. Typical examples are corn, oats, wheat, barley, rye, and rice. These plants belong to the Grass Family just as much as bluegrass, redtop, timothy, and other plants commonly included when we speak of grasses in general. It has been said that more people obtain their food from the grasses than from any other group of plants. When we consider the importance of wheat in the western world and rice in the eastern world, we can well realize the truth of this statement.

For purposes of classification, corn is usually considered separately from the so-called small grains. For this reason we shall discuss corn and grain sorghums in a separate chapter. The other grain crops will be considered under the heading of cereals.

PRACTICES COMMON TO ALL CEREAL CROPS

While each cereal crop will be discussed in detail, it is desirable to consider the practices which are common to all. In general, the same principles apply to wheat, oats, barley, rye, and other crops. We shall consider the practices of seed-bed preparation, sowing of the seed, and problems of harvesting. Deviations from these procedures will be considered in connection with each crop.

PREPARATION OF SEED BED

Assuming that the farmer is located in a region that has suitable climatic and soil conditions for crop growth, we may regard the careful preparation of the soil as a prime essential in successful cereal production. The land must be plowed at the proper time and at the depth most suitable for the crop and the type of soil. The subsequent operations of disking, harrowing, or dragging and cultipacking, are important factors in the proper preparation of a seed bed which will further the most rapid growth of the crop. Without doubt, a little extra care spent in seed-bed preparation may result in reduced costs of production. Poorly-prepared soil usually results in slow growth of the seeded crop and greater competition from weed plants.

Plowing. While it is possible to prepare a seed bed for small grains without plowing, as where a grain crop follows corn, many of our grain fields require plowing, especially in the great winter-wheat areas of the United States. Where the farm has been in grass, the problems of plowing are increased, as more power is required. On these fields a long, sloping type of moldboard is most successful. The so-called sod-buster types of plows embody the desired principles. In most areas it is common to seed a heavy-feeding crop, as corn, cotton, or sorghum, following the breaking of sod. Then the small grains follow the cultivated crop. Such land is more easily plowed and may be prepared with a plow equipped with a broader moldboard set at a more sloping angle. On most soils the plow should be equipped with both a jointer and a coulter. These enable the operator to do a better job of turning under the material on the surface. Where growth is heavy, a disk may be used prior to plowing. A heavy chain attached to the plow beam to drag the weeds down will aid in securing better coverage.

In the West it is common to use the one-way plow. This implement uses large disks instead of a moldboard. It is believed that this plow requires less power for its operation than the ordinary one.

At the best, plowing is an expensive operation, since the work is heavy. The careful operator sees that his plowshares are kept sharp and properly pointed. Likewise, it is desirable to keep the moldboard bright to insure proper "scouring." Whenever the plow is not in use, it should be coated with a layer of heavy grease. Exposure, even for a few days, will rust the metal and make plowing more difficult.

Firming the Soil. Where the land is fall-plowed and the crop is seeded the next year, it is usually best to leave the plowed soil undisturbed until spring. One of the most important advantages of fall plowing is that it permits nature to act upon the soil, to improve its physical structure and make the plant foods more readily available for the growing crop. Following spring plowing, and before the soil is too dry, the disk should be used to break the lumps of soil as the first step toward seed-bed preparation. On many heavy soils, if there is delay, the hard lumps are difficult to pulverize. Most operators disk the soil almost as rapidly as it is plowed.

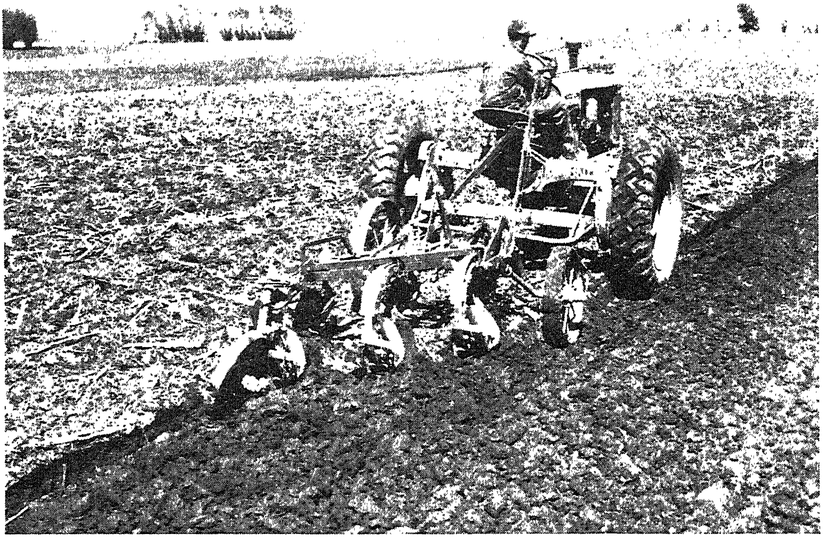


Figure 27. A good job of plowing is essential for best soil moisture conditions.

After the land has been disked, it is further leveled and firmed by a smoothing harrow. The most common implement is the spike-tooth harrow. It breaks the clods and levels the soil, so that uniform planting is possible. All ridges and low places also should be leveled. To insure rapid germination and growth, the soil must be firmed. As we have seen earlier, the water moves through the soil from particle to particle. If these particles are too far apart, the resulting air spaces hinder water movement and prevent best growth.

The cultipacker, an implement which firms the soil, is valuable under many conditions. Many farmers use an ordinary roller or a plank drag. The advantage of the cultipacker over these is that it leaves the soil ridged, thus making it less subject to wind and water erosion. The plank drag is heavy to pull and requires more power. Its use is to be discouraged except as a last alternative.

Crops, such as the small-seeded legumes, are especially affected by loose soil. Failures with these crops may frequently be traced to a loose seed bed. Soils which contain considerable organic matter must be given special care to effect proper firming to conserve the available moisture supplies. In dry seasons, the proper use of the cultipacker may prevent a crop failure.

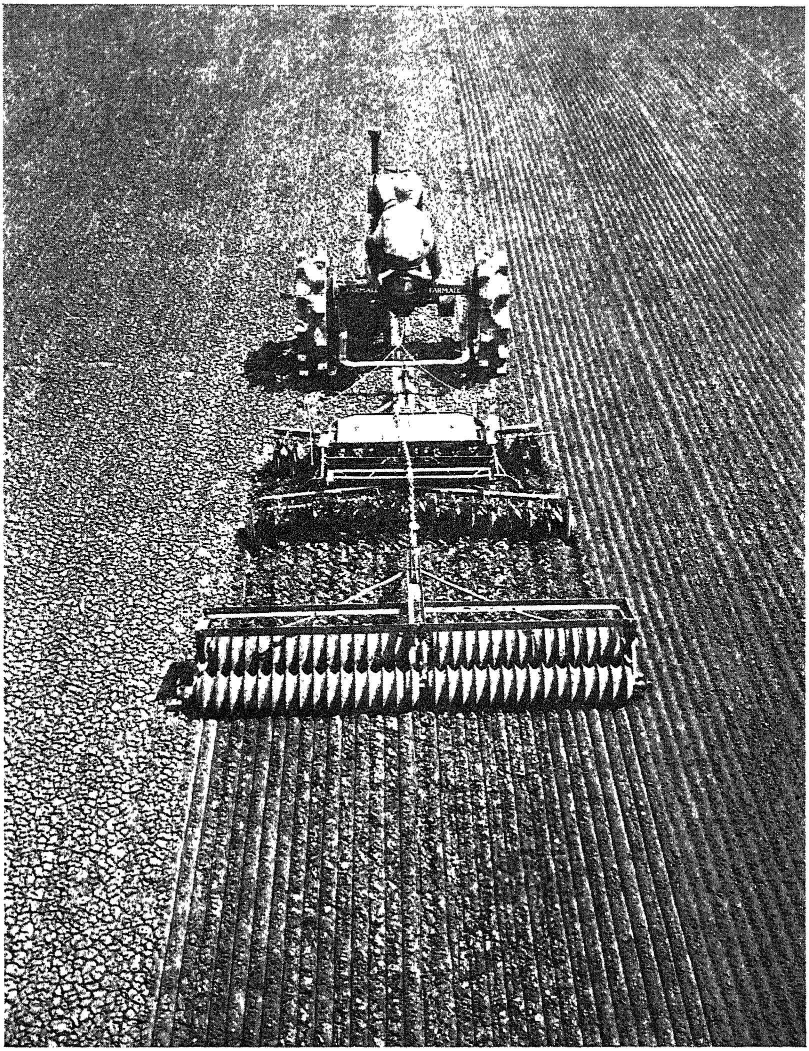


Figure 28. The cultipacker, following the disk, produces a firm seed bed.

Fertilizing. When the crops are fed to livestock, the manure should be returned to the soil. Manure provides the most economical type of fertilizer under average conditions and has the added advantage of increasing the organic-matter content of the soil, a factor of great importance on most soils.

With the small grains, care must be taken to avoid an excess of nitrogen. Too much nitrogen may cause lodging of the plants. For this reason, it is usual to grow a heavy-feeding crop, as corn, sorghum, or cotton, ahead of the grain. These crops utilize the excess of nitrogen and leave the soil in proper condition for grains.

Most grain soils benefit from an application of phosphorus-bearing fertilizers. The superphosphates are best under most conditions. Applications averaging 200 to 400 pounds per acre in the rotation are desirable. Some use is made of raw rock phosphate. Where this is used, much greater applications are made, ranging from 800 to 1,500 pounds per acre.

Applying the fertilizers at the time of planting, with a fertilizer attachment on the grain drill, is a recommended practice. The fertilizer is then placed close to, and in partial contact with, the seed. Possibly there is some injury to seed, but the added vigor of growth and the subsequent stooling offset the damage.

SOWING THE SEED

Following the seed-bed preparation comes the actual planting of the crop. The selection of viable seed of varieties suited to the region should precede seeding. It is advisable to choose varieties recommended by your state agricultural experiment station. The use of poor varieties may render the labor of a season useless. One should always check on the viability of seed by making a germination test. The fanning mill will remove weed seeds and undesirable light-weight grain. Seed treatment for disease control may be necessary. Oats and wheat should be treated for smut.

Time of Planting. With most crops, early planting is best. Winter wheat and rye should not be planted until after the Hessian fly has laid its eggs in the fall. The time of egg-laying is announced each year by state entomologists.

The spring-sown grains, oats, barley, spring wheat, and flax should be planted as early in the spring as practical. All germinate at low temperatures and are resistant to frosts and a cool season. The advantages of early planting lie in speeding growth as much as possible before the coming of hot weather during midsummer.

Methods of Planting. The two general methods of planting grain crops are drilling and broadcasting. To ascertain which method is better has led to many experiments. Both methods may be used on a given farm. Each has its advantages and disadvantages. Let us consider each system separately.

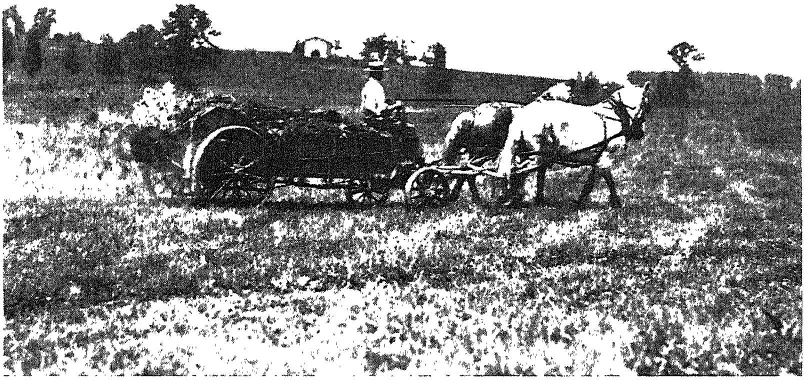


Figure 29. Barnyard manure is the best fertilizer under many conditions.

The drill is an implement permitting the operator to control the rate of seeding and the depth to which the grain is placed in the soil. With high-priced seed the rate is especially important, since less seed is required when drilled. The broadcast method requires additional seed, since enough must be sown to allow for that which has not been covered.

As a rule, most farmers drill wheat, barley, rye, flax, and rice. Many farmers use the broadcast method for oats. The practice varies in different sections of the country. Probably no section has as many supporters of the broadcast method as the Corn Belt. Here it is the general practice to grow oats in rotation with corn. The oat seed is usually not high in price and the crop may succeed even under rather unfavorable conditions. Farmers often use the endgate seeder, a machine attached to the back end of the wagon box. It is equipped with one or two rotating fan-like distributors which broadcast the grain for several feet. This machine makes possible very rapid seeding, and thus appeals to the farmer. The land should be disked before broadcasting, although some farmers disk after sowing. The disked land is then harrowed, and seeding is complete. If conditions are favorable, this method of seeding may be as successful as the drill method. If moisture supplies are inadequate, then the drill-sown grain may make the better growth.

Where the land has been in row crops the previous year, the drill permits more even seeding. It is not uncommon to see broadcast fields showing thick and thin strips of grain according to the ridges and valleys left by the last cultivation of the previous year. In years of moisture deficiency the drill permits the placing of the seed in a more advantageous position for growth.

When grasses or legumes are seeded with the grain crop, they may be planted with an attachment on the drill. In few cases should the seed be mixed with the grain and planted at the same depth. If no attachment is available, the small seeds may be broadcast over the surface after the grain is sown and harrowed lightly to cover.

Another advantage of the drill is that it permits the use of a fertilizer attachment which places the fertilizer near the seed at the time of planting. This method of application has been shown to be the best.

HARVESTING

The small grains are harvested by several methods. Most crops are grown for the ripe grain. Crops are ready for harvest when the seed is in the hard-dough stage. The time of harvest will depend upon the machine used. If the binder is used, the grain may be cut early and placed in shocks to complete the drying process. If the combine harvester is used, the crop is left until it is very dry, usually containing not more than 14 per cent of moisture. The harvested grain may then be stored. In some areas, the combine is used with a windrower, a machine which cuts the grain and spreads it on the stubble to dry.

Self-binder. The most common machine for harvesting grain crops is the self-binder, or, as farmers usually refer to it, the binder. This machine cuts the grain and binds it into convenient-sized bundles. For many years the binder has been found on nearly every farm east of the Mississippi River. The development of this machine, the so-called reaper, was heralded as a major event in the history of agriculture.

The binder makes it possible to cut grain a little early, so as to provide a better quality of straw. On many farms where livestock is kept, the straw is of great importance. Some farmers utilize the straw for roughage feed as well as for necessary bedding during the winter months.

The binder-harvested grain is usually placed in shocks to dry. Threshing may be from the shocks or from stacks. In the latter method the bundles of grain are placed in stacks for threshing. If it is necessary to delay threshing until late in the season, stacking is advantageous, as it provides better protection against the weather. Some farmers prefer to stack their grain, as they are able to do so with but little extra help and thus can handle most of the threshing labor themselves. Often the stacks are built near the farm buildings and the straw is blown into a barn or used to build serviceable straw sheds by placing it over a framework of poles and wire.

Occasionally, a farmer wishes to feed bundle grain, as oats, to his livestock. When so fed, the grain should be harvested fairly green. The dried bundles may be placed in the haymow and fed without preparation. A great disadvantage to this method is the almost certain damage from rodents during storage.

When the grain is not thoroughly mature, bundles should be small to prevent spoilage from molding. Likewise, small shocks will speed drying.

The Header. The header is a machine which clips off the heads of the grain, elevating them into a rack which moves alongside the header. The headed grain is placed in stacks for later threshing. The header is being rapidly replaced by the combine.

The Combine. The combine is so-called because it cuts and threshes in one operation; in other words, it combines the operations of the binder and the threshing machine.

The combine has been used for many years in the dry sections of the West. The first combines were huge affairs requiring much power for their operation. It was believed that they could be used to advantage only where very large fields of grain were grown. Soon it became apparent that, if certain adjustments were made, they might be used in more humid areas. Adjustments have been made rapidly during the past few years, and now combines are used in nearly all areas. An important change has been made in the type of machine. The manufacturers have built small outfits suited to smaller acreages. They require less investment and may be operated on smaller fields.

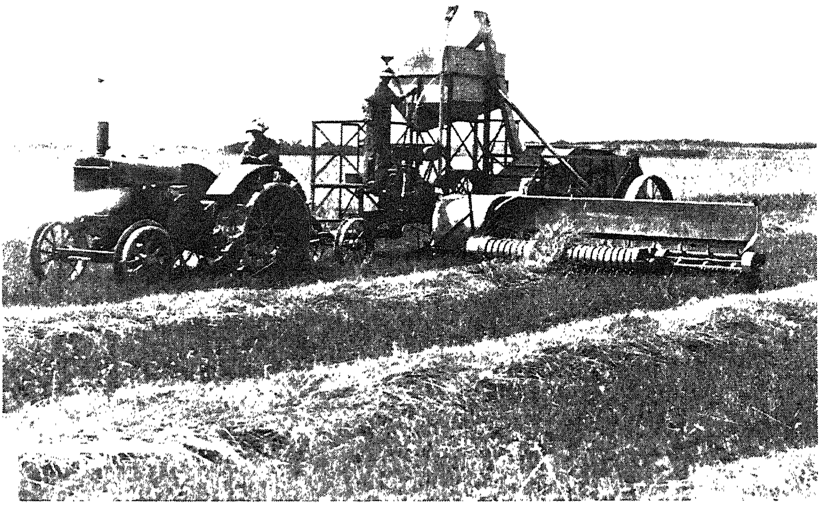


Figure 30. A combine with a pick-up attachment which makes possible the use of the combine under more humid conditions.

The Windrower. Many operators in the more humid regions use a windrower to harvest the grain at the proper time. The cut grain lies in a swath on top of the stubble. It dries rapidly, as the air circulates freely through it. The combine with pick-up attachment then gathers the cut grain from the stubble and completes the harvesting operation by threshing it. Many operators believe that grain harvested in this manner dries more rapidly and withstands more wet weather than when it is placed in shocks to dry.

PRACTICES IN PRODUCTION OF INDIVIDUAL CROPS

While certain principles apply to the grain crops as a whole, some consideration must be given to the exceptions. It is recognized that not every reader will be interested in the detailed discussion of each crop. It is essential, however, that this treatment be available for those who are interested. Accordingly, the more specific phases will be presented for each of the major crops.

SPRING-WHEAT PRODUCTION

The spring-wheat varieties are seeded in the spring and mature during the following summer. From a market viewpoint, the term "hard red spring wheat" refers to those varieties that have a red kernel. (Chapter IX, *Agriculture II.*) Considering only the time of seeding and growing the crop, white wheats with spring habit would be included in this group. As we have learned previously, the white wheats are used for pastry and cracker flour, while the hard red spring wheats provide flour of the high quality and possessing the characteristics required for bread-making.

Where Grown. As listed in Table XII, *Agriculture I*, the principal spring-wheat states are North Dakota, South Dakota, Montana, Minnesota, Washington, and Oregon. To a more or less limited extent, spring wheat is grown in all the northern states. The first four states are most important in the production of the hard red spring wheats.

In the Pacific Coast area and in the Northeast are found considerable acreages of white wheat. Important states in the production of white wheats are Washington, Oregon, California, Idaho, Michigan, and New York. Some of the varieties grown are seeded in the fall and are considered as white winter wheats. This practice is especially true in the eastern states listed.

In general, the spring wheats should be grown in areas where winter wheats will not succeed either because of low winter temperatures or lack of snow covering. Where winter wheats can be grown successfully, they usually yield more than the spring types.

Soil and Climatic Adaptations. Spring wheats are especially suited to fertile, fairly-heavy soils. The soils found in the rich Red River Valley of North Dakota and Minnesota are especially suited to the production of spring wheat. An adequate supply of nitrogen, together with phosphorus, potassium, and other elements usually present in most soils, is essential to the production of high-quality spring wheat. High annual precipitation is not necessary, provided the rainfall comes during the growing season. Wheat of very high quality is produced in regions having a total rainfall of 12 to 20 inches. Where summer fallow is practiced, as in the Pacific Northwest, satisfactory yields are produced with a minimum amount of rainfall.

A relatively cool growing season is best for spring wheat. Hot, humid days are likely to result in grain of lower quality. They are also favorable to the development of destructive diseases, such as black-stem and leaf rusts. The long summer days of North Dakota are ideal for hard red spring wheat.

Seeding. For spring wheat it is especially desirable to plant the crop as early as possible. For this reason, fall plowing is preferred, except where wind or water erosion are likely to be serious. The fall plowing permits earlier seeding in the spring. The fall-plowed land should be left as rough as possible, to catch the drifting snow and to facilitate the entrance of moisture into the prepared surface. As indicated earlier in this chapter, thorough seed-bed preparation involves the use of the disk and smoothing harrow to secure a level, firm surface.

Having chosen an adapted variety recommended by your state agricultural experiment station, the seed should be cleaned thoroughly to remove trash, weed seeds, and low-quality grain. In most sections, it is desirable to treat the seed for bunt or covered smut, as outlined in Chapter IX, *Agriculture I.* The use of an organic mercury dust is desirable under most conditions. If loose smut was prevalent in the field from which the wheat was harvested, the hot-water treatment may be used to advantage. (Chapter IX, *Agriculture II.*)

Wheat is seeded with a grain drill in most areas. Broadcasting is undesirable, as it results in waste of seed and poor stands. Rates of seeding vary with the rainfall. In the drier areas 4 to 5 pecks are sufficient. In the more humid areas, 6 pecks are used. Too heavy seeding may result in weak plants likely to lodge before harvest.

Rotation. In many sections, spring wheat is grown on summer fallow land, that is, wheat is grown continuously on a given area, with summer fallow intervening. In many of these sections it is impossible to practice an adequate rotation, since moisture is a limiting factor. Without question, this practice will result ultimately in soil depletion and the necessity for soil rebuilding. In more humid sections where cultivated crops may be grown, a good rotation may be followed. The rotation practiced will depend upon the type of farming, whether livestock or grain farming. On the farm producing livestock, typical rotations are:

Rotation I

1st year: Cultivated crop, as corn, sugar beets, or potatoes.
2nd year: Spring wheat.
3rd year: Sweet clover, used for pasture, hay, or seed.

Rotation II

1st year: Cultivated crop.
2nd year: Spring wheat.
3rd year: Oats or barley.
4th year: Hay.
5th year: Pasture.
6th year: Cultivated crop.

Various modifications may be made of the above rotations, so as to provide feed, a cash crop for sale, and a cultivated crop for weed control.

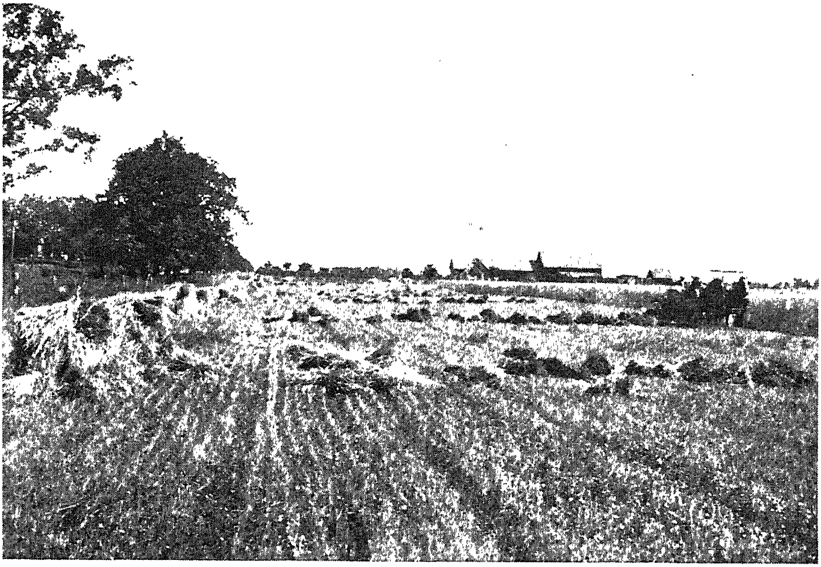


Figure 31. Most of the wheat grown in the eastern half of the United States is harvested with a binder and placed in shocks to dry.

Harvesting. Spring wheat should be harvested when the grain is hard. If combined directly from the standing grain, the seeds must be nearly brittle. If a binder, header, or combine windrower is employed, harvesting may start when the grain is in the dough stage. Attacks of black stem rust do not warrant early harvest. The grain should be permitted to mature the same as though rust were not present.

Grain harvested with a binder or header is threshed as soon as dry. The threshing machine should be checked carefully to avoid damage to the kernels. The grain is frequently so dry that much of it is broken. This breaking may be remedied by removing some of the concaves and reducing the speed of the cylinders.

Storage and Marketing. Many grain farmers make a practice of hauling the threshed grain directly to the elevator. In the dry sections of the West, the grain may be bagged on the combine and the bags dropped to the ground to be gathered later. Farther east it is more common to collect the grain in wagons as threshed and haul it to the place of storage. Many farmers possess no storage facilities and must deliver the grain to the elevator. The farmer with storage space may prefer to hold the grain until later with the hope of securing a better price. Usually, the period of harvest is an unfavorable time to market, as the supply of marketed grain is great. One who stores his grain must consider the cost of storage and take this into consideration in determining whether to market at once or to hold the crop. Some large producers sell grain in advance for future delivery and thus protect themselves against wide fluctuations in market prices.

Uses. The hard red spring wheats are noted for their value as bread wheats. Usually, the grain is rich in protein of a quality which produces a flour capable of large loaf volume. Most of this wheat is used for the best quality of flour. In the marginal areas of spring-wheat production, large quantities of low-quality wheat are used for poultry and livestock feed.

The white spring wheats, as a class, are low in high-quality protein and are unsuited to the manufacture of strong flour. These flours are suited to the making of pastries, crackers, and other products whose quality is best when made from a weak flour. These white spring wheats include both the common, or *Triticum vulgare,* and the club, or *Triticum compactum,* varieties.

PRODUCTION OF DURUM WHEAT

The durum wheats *(Triticum durum)* are not of as great importance as the common types. They constitute about two per cent of all wheat grown in the United States. They are of importance in only three of the states, North Dakota, South Dakota, and Minnesota. In many respects their requirements, habits of growth, and management coincide with those outlined for hard red spring wheat. We shall consider the durums in detail only as they vary from the spring wheats.

Where Grown. The three states listed above produce most of the durum wheat. That the area of production will spread greatly is very unlikely for two important reasons: (1) the demand is limited, and (2) the durums do not produce high-quality grain in other sections. Unless one lives within this area, other crops are more desirable than the durums.

Soil and Climatic Adaptations. It is safe to state that these are the same as for hard red spring wheat. It is probable that the durums are even more restricted than the spring wheats. While crops may be produced beyond the limits of the Durum Belt, the low quality of the grain is likely to result in very low prices.

Seeding. The general operations are the same as for spring wheat. Most varieties of durum wheat have a very large kernel. The leading amber-colored-kernel varieties are Mindum and Kubanka. The red-kernel varieties have little place, being suited only as feed for livestock. For this reason seeding rates are heavier. The average rate of seeding is 6 to 7 pecks per acre.

Rotation. This rotation is the same as that outlined for the hard red spring wheats. Most durum wheat is produced on grain farms where little or no livestock is kept and the grain is marketed.

Harvesting. Methods are the same as for hard red spring wheat. It is important that the crop be permitted to complete its maturity, since a hard, flinty kernel is desired. Early harvesting may result in starchy, low-grade grain.

Marketing. These problems are similar to those of hard red spring. The price received will vary greatly according to the hardness of the grain. Where a farmer may make a nice profit from hard amber durum, his neighbor may lose money by producing a starchy, low-quality crop. Since the demand is not equal to the supply, the market is very exacting in its requirements. For this reason, it is imperative that only the highest quality of grain be produced.

Uses. The primary use of durum wheat is for the manufacture of macaroni and similar products. The market demands a hard, clear, amber-colored kernel for this purpose. A limited quantity of durum wheat is used to blend with bread wheats for flour manufacture. Some durum is fed to livestock, although the very hard kernels are somewhat objectional. The red kernel durums may be used only for livestock feed. These varieties are grown to a limited extent only.

PRODUCTION OF WINTER WHEAT

The winter wheats receive their designation from the fact that they are seeded in the fall, remain dormant during the winter, and are harvested the following summer. The varieties possess those inherited characteristics which enable them to pass through a cold season which would destroy the more tender spring wheats. By far the major part of our winter wheats are the red-kerneled types. They include the two most important market classes of wheat, hard red winter and soft red winter. The former has been estimated to make up 40 per cent of our wheat, and the latter 34 per cent. While the varieties included in each class differ widely, there are many points of similarity. Accordingly, both classes will be discussed and their differences described.

Where Grown. In Chapter IX, *Agriculture II*, we learned where each of the classes, hard red winter and soft red winter wheat, are grown. With Kansas as a focal point, the hard red winter wheats are centered in the Southwest with some production eastward in Iowa, Illinois, Missouri, and Minnesota, and northwest in Montana, Idaho, Utah, Washington, and Oregon. The soft red winter wheats are grown farther to the east under conditions of higher rainfall. There is considerable overlapping with hard red winter in the states of Kansas, Oklahoma, Texas, Missouri, and Illinois. In addition to these states, production is centered in Ohio, Indiana, Pennsylvania, and neighboring states.

The persons living in these sections of the United States are more likely to be successful in producing winter wheat than in growing the spring types. The choice between hard red winter and soft red winter wheat will depend largely upon location, east or west. In the more humid areas, soft red winter is preferred; in the drier areas, hard red winter varieties may be more profitable.

Soil and Climatic Adaptations. Both hard and soft red winter wheats respond to a fertile soil that is well supplied with an abundance of nitrogen. As with spring wheat, these wheats do best on heavier types of soil and are not usually successful on sands unless they are highly fertile, as in river valleys where the land is subject to overflow and infiltration of silt. Such soils as are found in the Mississippi River Valley and its tributaries produce excellent crops of winter wheat.

The hard red winter wheat varieties are characterized by a hard, flinty kernel much like that of hard red spring. To produce this type of grain a region of low atmospheric humidity is desired. These moisture conditions, as found in Kansas and adjoining states, are similar to those of the hard red spring wheat area farther north. Under favorable conditions, large yields of high-quality wheat are produced. The principal limiting factor in this region is moisture. Adequate rainfall to secure good growth in the fall is essential. Late winter snows or spring rains are needed to start growth in the spring and insure a crop. To the north and east, winter injury may result from a lack of snow covering. Snow acts as a blanket in protecting wheat. Injury from heaving of the soil as a result of alternate freezing and thawing is very common in the regions of mild winters. With adequate snow covering, hard red winter wheat may be grown successfully as far north as the Canadian line, although its general growth is not recommended except in the more favorable sections of the Pacific Northwest and Montana.

The soft red winter wheat varieties are better suited to the humid winters of the eastern half of the United States. As a group, the soft red winter wheats are more likely to be injured by drouth or low temperatures. Accordingly, they are grown in regions of adequate rainfall and milder winters. While they do not produce as hard, flinty grain as the hard red winters, they do have a place in our country's agriculture.

Seeding. As with spring wheat, the hard red and soft red wheats are seeded with a drill. In the West, large power drills are common. On the smaller farms of the East, smaller drills are more common. In the Southwest, early plowing is desirable, as it conserves the moisture essential for fall seeding. Weeds are destroyed by frequent tillage. A firm seed bed is essential for rapid germination. Some farmers of the East use a narrow, one-horse drill to seed wheat between the rows of corn. Many of the Southeast harvest their corn as bundle corn and plant wheat in the stubble.

The rate of seeding winter wheat ranges from as low as 3 pecks per acre in the driest regions to 6 pecks in the more humid areas. As a general recommendation, 4 pecks in Kansas, 5 pecks in Missouri, and 6 pecks in Pennsylvania may be safe. With adequate seed-bed preparation and the use of good seed, recommended rates may be reduced somewhat.

Rotation. As with hard red spring wheat, hard red winter wheats are grown where winter temperatures will permit, under very dry conditions, alternating with summer fallow. Where moisture supplies are more adequate, wheat is grown in rotation with cultivated crops. Types of rotations are:

Rotation I
1st year: Corn or grain sorghum.
2nd year: Wheat.
3rd year: Alfalfa—5 to 8 years and into cultivated crops again.

Rotation II
1st year: Cultivated crop.
2nd year: Spring grain.
3rd year: Wheat.

Rotations in the soft red winter wheat area permit a wider range of selection, as many more varieties of crops are grown. Typical rotations are:

Rotation I
1st year: Cultivated crop.
2nd year: Wheat.
3rd year: Oats.
4th year: Clover.

Rotation II
1st year: Cultivated crop.
2nd year: Oats.
3rd year: Wheat.
4th year: Clover.

Many variations from these rotations are followed, depending upon the crops grown. The cultivated crop is usually a leading cash crop and may be corn, cotton, tobacco, or other crops adapted to local conditions. Wheat is ideal as a companion crop for the small-seeded grasses and legumes, since it does not shade the ground greatly and is removed fairly early in the season.

Harvesting. Both hard red and soft red winter wheats are harvested when the grain is hard. Where the grain is combined directly it must be dry. The combine is the most common harvesting implement in the hard red winter wheat regions, while the binder and shock threshing predominate in the soft red winter wheat area. During recent years, the use of the combine has increased greatly in the eastern areas. Stack threshing is not as common as it was a few years ago. The increase in the use of small threshing rigs has made it possible for farmers to get their threshing done earlier. In the humid East, the straw is of great importance and farmers save it all. For that reason some are reluctant to use the combine. Frequently, the threshed straw is stacked in the barnyard to be available for winter use.

Storage and Marketing. In the Southwest, much of the wheat is hauled from the field to the elevator. Many farmers do not possess storage facilities and must market their grain as threshed. Frequently, during years of a large crop, storage facilities are taxed to the utmost and grain may be dumped on the ground near the railroad. Losses, therefore, are likely to result even under the best conditions. Some farmers store their grain until the market conditions are more settled. This practice involves added expense.

In the soft red winter wheat area, farmers are more likely to have storage bins for their crop. These farmers usually store the crop for later sale. Some follow the practice of immediate sale; but, with better storage facilities, they are in a better position to hold the grain. In this section, a certain amount of wheat may be fed to livestock. Whether it may be so fed is dependent upon the general demand for wheat and consequently on the market price.

Diseases and Insects. The choice of variety is important. Varieties resistant to the diseases of wheat are desired. The best varieties for each section are listed in Chapter X, *Agriculture I.* Seed treatment for the control of covered and loose smut is through the use of organic mercury dusts.

The winter-wheat grower must contend with a very important insect, the Hessian fly. It may be controlled by planting wheat after the adult has laid its eggs. The "fly-free" dates are announced each year by the state entomologists, who study the habits of the insect. (Chapter IX, *Agriculture II.*) Considerable progress is being made in the breeding of varieties resistant to this pest.

Uses. The soft red winter wheat of the more humid areas is used primarily for flour, although a large percentage of it is utilized for livestock feed. The flour from soft red winter wheat does not possess a strong gluten and for patent flour is blended with hard red winter or hard red spring flours. It is ideal for pastry and the making of hot biscuits. Much of it is used in this manner in homes where biscuits form a regular part of the diet.

Both hard red and soft red winter wheat, in the early stages of growth, provide excellent pasture for livestock. Care should be exercised to avoid overgrazing. Livestock must not be permitted in wet fields, for their trampling will prove destructive.

PRODUCTION OF OATS

Oats is the third most important crop in the United States. It is grown in practically every section. In the humid regions no other crop is more reliable than oats. In spite of the fact that cost accounts show that it usually is not a paying crop, the oat is grown widely. Without a doubt, the ease of growing a crop is largely responsible for its popularity. Most farmers like oats because of the wide range of uses that may be made of the crop on nearly every farm.

Where Grown. In Chapter X, *Agriculture I*, is a map of the oat-producing states. An examination of this map shows that oats are produced in nearly every state. The greatest concentration is in the states of Iowa, Illinois, Minnesota, Wisconsin, Nebraska, Indiana, and Ohio.

The oat plant, like many other grasses, is best suited to a cool climate. For this reason, the best yields and highest quality of grain are produced in the northern states. Iowa leads in oat production, not primarily because the oat is better adapted there, but because it fits in especially well with the common rotation of oats, clover, and corn. The oats grown in the South are different from those of the North. As a rule, the southern oats are red, while those of the North are usually white or yellow.

Oats will succeed on a wide range of soils. They require more water than most grain crops and fail where water is a limiting factor. For this reason, coarse sandy soils are not suited to oat production. Any soil of fair fertility will produce a crop of oats. Of course, with lower fertility, yields are decreased. Oats should not be grown on soils excessively rich in nitrogen, as, then, lodging is likely to occur.

Varieties. The choice of variety is important. In the North, most varieties are of the *Avena sativa* species. (Chapter X, *Agriculture I.*) Stem-rust-resistant varieties are available in most states, and great progress is being made in the development of varieties resistant to crown rust. In the warmer sections, early-maturing varieties usually yield best, as they tend to mature before the coming of hot weather. Farther north, the later varieties are likely to yield more. Care must be taken to avoid seeding short-straw varieties on light soils, else the crop is likely to be too short to harvest. The straw of oats is the best all-around farm straw. A good variety should produce enough for the farm needs, especially on the livestock farm.

The red oat of the South *(Avena byzantina)* is better suited to produce satisfactory yields under the less favorable conditions prevailing there.

The hull-less oat *(Avena nuda)* is not of great importance. A recently developed variety produced by the South Dakota Agricultural Experiment Station is Nakota. Hull-less oats are difficult to seed, as they tend to pack together and do not pass through the drill uniformly. In the latitude of Tennessee, the fall or winter oat has proved popular.

Seeding. Where most of the oats is grown, in the Corn Belt, the common practice is to broadcast the seed on cornstalk land. The land is disked and harrowed with a minimum of labor, which accounts in a large part for the popularity of oats. In the East, it is common to plow the land before seeding the oats. A better seed bed is made, which, when there is a shortage of moisture, may result in much higher yields. If heavy cornstalks are left in the field, they should be cut up with a heavily-weighted disk.

Whether it is better to drill or to broadcast is debatable. The primary advantages of the broadcasting method are the saving of labor and, where the stalks are heavy, it may be possible to seed earlier. With the advantages of early seeding, higher yields may result. The farmer who does not own a drill doubts the wisdom of making the purchase for seeding oats. When all factors are considered, probably the broadcast method will be found preferable. When broadcast, 3 bushels per acre is an average rate. If the drill is used, 2 bushels are sufficient. Since seed cost is low, most farmers seed heavier than necessary.

Rotation. One of the most common rotations of the Corn Belt is oats, clover, corn. The oat crop serves as an excellent companion crop for the grasses and legumes where moisture is abundant. Under drier conditions, wheat or barley are superior, as they do not require as much water as oats. Regardless of the cultivated crop grown, oats follow it well. A heavy-feeding crop removes the surplus nitrogen and makes possible easy seed-bed preparation for oats.

Harvesting. Since most oats are grown in the humid sections, a greater percentage of the crop is binder-harvested. The combine is being used to a greater extent each year, as its popularity increases. Since oat straw is valuable, many farmers prefer the grain binder, as it permits the saving of the straw. The use of the binder also permits harvesting a little early, thus yielding a high quality of straw which may, under many conditions, provide valuable feed.

Storage and Marketing. The oat is not a high-value cash crop. The price paid is usually low. While many farmers market oats, a large percentage of the crop is fed on the farm. For this purpose, the crop is stored in bins until used. The Corn-Belt farmer who produces oats as a cash crop usually markets directly at the time of harvest.

Uses. The average oat is about 30 per cent hull. This hull is largely fiber and of little value as feed. For this reason, oats with the hulls attached are not so valuable as wheat or barley. The oat is high in percentage of protein and, because of this fact, is splendid feed for young stock. Because young pigs thrive on hulled oats, some farmers prefer to use the crop for hog feed. Most farmers feed oats to their work horses and often, also, as a part of the fattening ration for cattle or sheep. Sheep can use oats to good advantage, especially when fed with other feeds. A small percentage of oats goes into breakfast foods.

Oats cut when in the early milk stage provide valuable hay. They are frequently used to provide emergency feed. As a pasture, the crop is palatable and nutritious. Properly preserved oat straw is palatable and serves to advantage, especially in years of feed shortage. While the greater part of the straw is bulk and of little feed value, it is used more than any of the other common grain straws.

PRODUCTION OF BARLEY

While barley is not grown as widely as oats, it is one of our important farm crops. In the drier sections of the Great Plains where corn is not adapted, barley makes a splendid substitute. The malting types of barley are important and provide a valuable source of income for the farmers producing them.

Where Grown. The map of barley production (Figure 64, *Agriculture I*) shows that the region of most concentrated production is in the upper Mississippi Valley region and in California. The growing of barley in other states has increased greatly during recent years, largely as a result of the development of the smooth-awn barley varieties. Doubtless, some oat acreage of the Corn Belt should be replaced with barley.

Soil and Climatic Adaptations. The barley plant will grow on a wide range of soils, but does best on fertile loams. It will yield better than oats on dry soils under most conditions. Where an excess of nitrogen is present, lodging may occur. Barley does best in a cool climate. Hot weather during flowering time is almost certain to result in a poor crop. For this reason, spring barley is unsuited to the South. The winter types of barley have been grown with success in the warmer areas. Because of their earliness, they tend to escape the heat of midsummer. The barley plant will grow under drier conditions than the oat. Thus we find that barley is grown in the Dakotas where it produces a feed crop that serves much the same purpose as corn.

Seeding. The seed bed should be prepared by plowing either in the fall or spring. As a rule, barley is seeded with a grain drill. As indicated above, if barley follows corn, all stalks should be turned under by thoroughly disking the stubble before plowing.

Barley is seeded at the rate of 1½ to 2 bushels per acre in most barley areas. The lighter rate of seeding is recommended for the drier sections. Also, if alfalfa or other small-seeded legumes or grasses are seeded with barley, the lighter rate may be advisable.

Rotation. Barley fits into the average rotation much like oats. It usually follows the cultivated crop. When it follows corn, it is important that the corn land be plowed well, as plowing aids in the control of a scab *(Gibberella)* which attacks both corn and barley. Where scab is a serious problem, it is well to modify the rotation, so that barley does not follow corn. This variation is accomplished by growing some other grain crop as wheat, oats, or flax after corn and preceding barley.

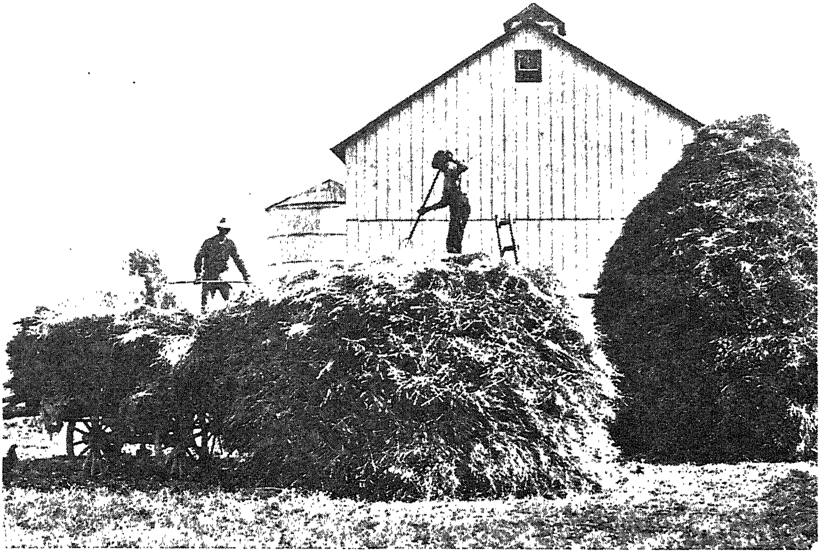


Figure 32. Many farmers in the northern sections stack the bundle grain until time to thresh.

Harvesting. If the crop is of malting quality, it should be permitted to ripen before harvest. Threshing should be done carefully to avoid cracking the kernels, as this damage reduces the value of the grain for malting purposes. Much can be done to avoid it by careful attention to the setting of the concaves.

Storage and Marketing. Much of the barley produced on the farm is fed. This barley is stored in bins on the farm. Barley sold for malting may be shipped directly or stored. Usually, it pays to store the crop, if facilities are available. If the barley grades "malting," it will usually command a premium over the common feed varieties. Sometimes this premium is large and may mean the difference between a profit and a loss.

Uses. The uses of barley were discussed rather completely in Chapter X, *Agriculture II.* The greater part of the crop is used as livestock feed. As the grain is similar to that of corn, it serves as a very good substitute. Many believe that an equal quantity of feed may be produced from an acre of barley as compared with corn, especially when consideration is given to the labor required to produce the two crops. Barley straw has little value except as bedding. The crop may be used as emergency hay or pasture, but it is not as well suited for these purposes as oats.

PRODUCTION OF RYE

Rye is an important food crop in some parts of the world. In this country, it is consumed only as a variety bread. For this reason, the greater part of the crop is grown for livestock feed. The opinion that rye will grow where no other crop will succeed is quite prevalent. Sometimes it leads growers to forget that rye will respond to fertile soils much the same as any other crop.

Where Grown. Rye is grown rather widely, especially in the eastern half of the United States. The region of concentrated production is in the northeastern quarter of the United States ranging eastward from North Dakota and South Dakota. The crop is grown in many sections of the South. Rye serves well as an emergency pasture crop and for that purpose is grown widely.

Soil and Climatic Conditions. Rye will succeed on almost any type of soil. Where the soil is low in fertility rye is often used to reclaim the land. Its common use along highways attests to its ability to grow under unfavorable conditions. The plant will grow successfully under drier and colder conditions than winter wheat. It is the best small-grain crop on sandy soils and here we find much rye. Its early growth in the spring enables it to mature so rapidly that it usually avoids the damage of dry midsummer. Rye will produce higher yields, however, if it is grown on fertile loam soils. Like oats, its ability to succeed under adverse conditions frequently results in its being seeded in poorer soils.

Seeding. Rye is seeded the same as winter wheat. It should be planted with a grain drill about September 1 in the North and in the latter part of November in the South. The seed should be cleaned and, if ergot is present, it may be removed. (Chapter X, *Agriculture II.*)

In the North, about 6 pecks of seed are sown, while in the Cotton Belt 2 to 3 pecks are sufficient.

A spring-sown type of rye is available, but spring varieties of rye have proved of little importance, since they have no advantage over the other spring-sown grain crops.

Rye is an undesirable weed in the winter-wheat areas of the Southwest and should be guarded against as an admixture in wheat.

Varieties. The best varieties are listed in Chapter IX, *Agriculture II.* The most important varieties in the North are Dakold, Rosen, and Wisconsin Pedigree No. 2.

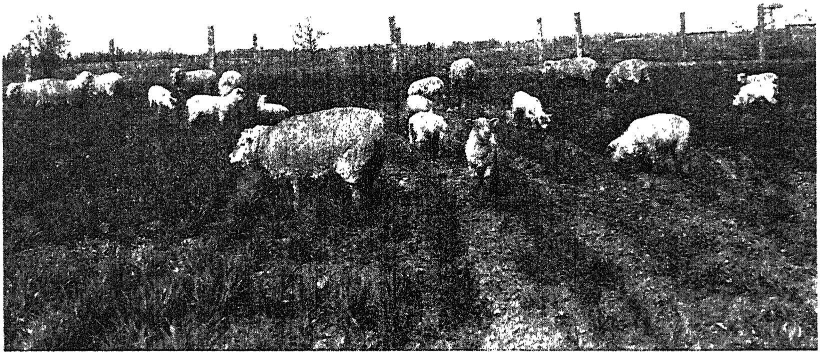


Figure 33. Fall-sown rye provides an abundance of fall and spring pasture.

Rotation. Where rye is grown as a regular crop, it fits into the same place as winter wheat. This place may be after other small grain in the North Central States or it may be after corn in the South. Like winter wheat, it may be sown between the rows of standing corn. Rye is one of the best crops for weed control, especially of such weeds as field bindweed *(Convolvulus arvensis).* When used thus, the land is fallowed until fall and the rye seeded. As soon as the crop is harvested, the fallow is repeated and rye seeded again. After about three years, the weeds should be under control.

Harvesting. As rye ripens before the other grains, its harvest comes first among the cereals. General principles involved were discussed earlier.

Storage and Marketing. The crop is stored and marketed as other grain crops are. Where it is used for livestock feed, it is held on the farm until fed. Those who market the grain usually haul it directly to the elevator.

Uses. As feed, rye is not as palatable as other grains and should be mixed with them. The presence of ergot bodies is frequently responsible for its unpalatability. These should be removed before feeding. A limited quantity of rye is milled for use as straight rye flour or for blending with wheat flour. The crop is very popular as an emergency pasture crop. It also serves well as a cover crop in orchards and in areas where it is desirable to control wind or water erosion. The use of the crop in weed control was discussed earlier in this chapter.

PRODUCTION OF FLAX

Many persons think of linen manufacture in connection with flax. Not much linen, however, is manufactured in this country. Practically all our flax is grown for the seed which is crushed for its oil. Unlike the other grain crops discussed previously in this chapter, flax is not a member of the Grass Family. It belongs to the Flax, or *Linaceae*, Family.

Where Grown. Most of the seed flax grown in the United States is produced in Minnesota, North Dakota, South Dakota, and Montana. The crop is suited to much the same region as spring wheat, although considerable flax is grown in Kansas, California, and Iowa.

Soil and Climatic Adaptation. Not many years ago, most farmers believed that flax was hard on the soil. After one crop, the flax failed. As we have learned, this failure was due to flax wilt. Today resistant varieties make it possible to grow flax on soil infested with the wilt organism.

Flax responds to a highly fertile soil, rich in plant food. Some farmers give flax the preferred place in the rotation, following a hay or pasture crop. It is not well suited to sandy or light soils.

The plant responds best to a cool climate. It does not require a great amount of moisture and succeeds in North Dakota with an average rainfall. Hot weather seems to depress the yields.

Seeding. Flax must be seeded as early as possible. Fall plowing will make it possible to seed earlier. A firm seed bed free from weeds is desirable. Flax is a poor competitor with weeds, so it should never be planted on weedy land.

A grain drill is the best implement for seeding. Since the seed is high in price, care must be exercised to prepare as nearly a perfect seed bed as possible and to use only the best seed. The acre seeding rates are 2 pecks in the drier sections and 3 pecks in the more humid ones.

Varieties. Wilt-resistant varieties are essential. The principal varieties are Bison, Buda, Linota, and Redwing. Punjab is grown in California.

Rotation. As indicated above, flax is given the choice place in the rotation. It is an important cash crop. During recent years, it has been one of the best-paying crops the farmer could grow. Normally, the flax follows the breaking of sod. It in turn may be followed by another grain crop. It serves ideally as a companion crop for small-seeded grasses and legumes.

Harvesting. Flax is harvested when the seed balls are mature. Most of the crop is harvested with a binder, shocked, and threshed. Where a combine is used, it is well to place the cut crop in a windrow to dry.

Storage and Marketing. The flax crop is grown for sale. The farmer may store it or sell directly. The price is usually satisfactory, as the United States does not produce enough flax to meet demands. The crop is difficult to store, as the very smooth, oily seeds find every minute hole in a bin. Special care is necessary in bin construction.

Uses. The principal use of flax is for linseed oil crushed from the seed. This oil is very important in the paint industry. The by-product from crushing provides a valuable meal much prized by livestock feeders. The straw may be used for rug manufacture and other fiber products. Recently, there has been an increased use of flax straw for the manufacture of cigaret paper.

PRODUCTION OF BUCKWHEAT

The buckwheat crop is grown in small patches and fields throughout the humid area. It is not widely grown and is of greatest importance in New York and Pennsylvania. The crop and its production were discussed fully in Chapter IX, *Agriculture II.*

PRODUCTION OF RICE

Rice is the principal food of millions of people. Surprising to most Americans, the United States produces rice for export market. Rice as grown in the United States is handled differently than that produced in China. In America large scale machinery is used and hand labor is reduced to a minimum.

Only four states, Louisiana, Texas, Arkansas, and California produce a large quantity of rice.

The principal problems and questions relating to rice production were discussed in Chapter X, *Agriculture II.* Here, it should be noted that rice production is very highly specialized. The prospective grower should not contemplate production unless he lives in an area where the crop is produced. Then he should make certain that he is familiar with the practical problems of production and marketing through first-hand contact with the producers.

Suggestive Questions and Activities

PRACTICES COMMON TO ALL CEREAL CROPS

Questions:

1. How does a sod plow differ from a stubble plow?
2. Why is it desirable to disk stubble before plowing?
3. Give reasons for fall plowing.
4. How should fertilizer be applied to small grains?
5. When would you use a combine in preference to a binder?
6. What is a combine pick-up attachment?

Activities:

1. Visit a farm and calibrate a drill.
2. Secure samples of different types of commercial fertilizer. Indicate where each is used.
3. Secure catalogs from different implement companies and become familiar with uses of implements used in the seeding and harvesting of grain crops.

SPRING-WHEAT PRODUCTION

Questions:

1. Name five spring-wheat states.
2. When should spring wheat be harvested?
3. What varieties of spring wheat are best for your state?
4. How is most spring wheat marketed?
5. How does a flinty kernel differ from a starchy one?
6. What use is made of spring-wheat flour?

Activities:

1. Plan a rotation including spring wheat.
2. Collect seed of different varieties of spring wheat. Label each and list its values and defects.
3. Make a map of the United States and outline the different wheat belts.
4. Examine heads of wheat and identify the parts.

WINTER-WHEAT PRODUCTION

Questions:

1. Which is more winter-hardy, hard red or soft red winter?
2. Are the wheat varieties grown in your section bearded or beardless?

3. How is loose smut of wheat controlled?
4. What is the best means of controlling black stem rust?
5. Why does soft red winter wheat flour produce better biscuits than hard red winter wheat flour?
6. What disadvantage can you see in growing a mixture of hard red winter and soft red winter wheats?

Activities:

1. Prepare a rotation including hard or soft red winter wheat.
2. From a newspaper list the prices paid for the different types of wheat.
3. Visit your local elevator and ascertain the names of wheat varieties he receives.
4. Study hard red and soft red winter wheat kernels. How do they differ?

OAT PRODUCTION

Questions:

1. What varieties of oats are grown in your state?
2. What is the average oat yield in your community?
3. What per cent of the oat is hull?
4. Botanically, what is the oat hull?
5. What is the legal bushel weight of oats?
6. Why is an organic mercury dust preferable to formaldehyde in treating oats for smut.

Activities:

1. Weigh a small sample of oats. Remove the hulls, weigh. Determine the per cent of hull.
2. Ask your father and neighbors why they grow oats. Prepare a statement giving advantages and disadvantages.
3. Plant oats in a flowerpot. Note the place where root and tillers develop.
4. Show by diagrams how to build an oat shock.

BARLEY PRODUCTION

Questions:

1. How does a 2-row differ from a 6-row barley?
2. What varieties of barley are grown in your community?
3. Why is a 2-row barley not preferred for malting?
4. How does barley compare with corn as a hog feed?
5. How does hull-less barley differ from ordinary barley?
6. What is the bushel weight of barley?

Activities:

1. Place sound and skinned barley to germinate. Note effect of injury on germination.
2. List the products prepared from barley malt.
3. Examine barley samples for discolored or blighted kernels.
4. Examine 2-row and 6-row barley kernels. Learn to identify each.

RYE PRODUCTION

Questions:

1. Why is rye regarded as a weed in Kansas?
2. What variety of rye is best in your section?
3. How does ergot live over?

4. Why is rye valuable in weed control?
5. Which matures first, rye or winter wheat?
6. Why is spring rye not more popular?

Activities:

1. Remove ergot from rye by using a salt solution.
2. Plan a layout for using rye as emergency pasture on your home farm.
3. Visit your local baker and find out how rye flour is mixed with wheat flour.

FLAX PRODUCTION

Questions:

1. What is the present market price of flax?
2. How is the oil separated from flax?
3. What effect does linseed oil have on paint?
4. Why is flax a poor weed competitor?
5. What is a flax-sick soil?

Activities:

1. Make a table showing the various products from flax.
2. Using the Yearbook of the United States Department of Agriculture, list the flax production of the United States and of Argentina.

BUCKWHEAT PRODUCTION

Questions:

1. How can one recognize a buckwheat plant?
2. When should buckwheat be harvested?
3. How does Silverhull differ from Japanese buckwheat?

Activities:

1. Grow buckwheat plants. Note the characteristic appearance of the leaves.
2. Compare the flavor of buckwheat cakes with the flavor of those made from wheat flour.

RICE PRODUCTION

Questions:

1. What states produce most of our rice?
2. How much rice is seeded per acre?

Activities:

1. Plant seeds of rice in a flowerpot and observe plant characters.
2. Study the United States Department of Agriculture Yearbook. List the leading rice countries of the world. Where does the United States rank?

CHAPTER XII

PRODUCTION OF CORN AND GRAIN SORGHUM

There are several species of corn of economic importance, of which the dent varieties are grown most widely. Throughout much of the agricultural area some corn is grown. Farmers living where the crop can be produced look upon corn as the ideal grain for feeding livestock. The unusual qualities of the corn plant which make it suitable for use either as a grain crop or as a forage are well known. The average American regards corn in various forms of preparation as a tasty and nutritious food.

In the sections of the nation where moisture supplies are insufficient for the best growth of corn, farmers have a worthy substitute, the grain sorghum. Like corn, the sorghums may be used either for grain or forage. Certain types, however, are especially suited for grain production; others are better for forage. The various types, their uses, and places in an agricultural program will be discussed in detail.

PRODUCTION OF CORN

It has been said that more farmers grow corn than any other crop. This fact indicates the general suitability of the corn crop to a wide range of conditions.

Where Grown. Corn is generally grown in areas of greater rainfall than is common with grain sorghums. The corn plant requires a warm, rich soil and moderately high temperatures during the growing season. Every state produces some corn, but the most intensive acreages are in the Corn Belt, located in an area bounded on the north by Minnesota, Wisconsin, and Michigan; on the west by South Dakota, Nebraska, and Kansas, and stretching eastward across Iowa, Illinois, Indiana, and Ohio. In nearly 75 per cent of the states corn is grown on 10 per cent or more of the cropland.

Soil and Climatic Adaptation. As corn production is limited by the length of the growing season, this favorable condition is essential to the highest yields. The crop does best where the seasons are warm and there is abundant, well-distributed rainfall.

The principal limitation in the West is lack of sufficient rainfall. The plant requires about 20 to 40 inches of annual precipitation with 5 to 7 inches during the critical months of July and August. Cool nights, in high altitudes, also slow the rate of growth. The most favorable corn-growing areas have a growing season of 130 to 150 days. The crop succeeds with a season as short as 100 days, and in the South the growing season may be 200 days or more. At neither extreme do we find the highest yields of the best corn. A region of southern Minnesota and eastward constitutes a northern limit for the most favorable growing season. Plant breeders have made much progress in developing varieties capable of maturing in shorter seasons. The season must be long enough to permit the development of a plant capable of producing fruit before frost. As one pushes northward one encounters cooler nights and a consequent slower rate of growth. Fortunately, the cool temperatures are offset in part by the long days of the northern latitudes. In the far South the plant tends to produce extreme vegetative growth at the expense of grain production. The quality of the grain, also, is not so high as that of the Corn Belt. The kernels are usually more starchy and of a lower protein percentage.

Corn is essentially a fertile-soil plant. It requires an abundance of plant food, especially nitrogen, phosphorus, and potassium for its best growth. For this reason, the corn farmer makes it a practice to give corn the favored place in the rotation. In short, the other crops in the rotation are planned so as to render the soil most fertile when the corn crop is planted. Many farmers have noted that certain varieties of corn are better adapted to poor soil than others. Workers at the Indiana Agricultural Experiment Station have found that some strains of corn tend to absorb harmful aluminum and iron compounds from the soil to the detriment of the plant. The plant breeders are considering these questions and undoubtedly will soon develop strains of corn especially suited to poor soils. The fact remains, however, that corn does best on fertile, deep soils. Heavy loams are best, but varying degrees of sandy mixtures are suitable, except where the sand is so coarse that the water-holding capacity of the soil does not permit growth.

Varieties. The principal types of field corn are the dents and the flints. The dents are by far the most important. The flint varieties are grown primarily in the New England States and in the northern border states where the growing season is too short for the best production of dent types. In the extreme South some flint corn is grown because of its greater resistance to damage from the corn-ear worm. Our discussion here will be concerned primarily with the dent varieties.

There exists a wide diversity in types of dent corn. The varieties are known as dent corns because of the indentation in the crown of the kernel. This indentation is the result of the shrinkage of the starch in the crown. The tendency at present is toward a more shallow, or smooth, indentation, as this has been found to be associated with early maturity and freedom from disease. There is also a trend toward the development of softer hybrids. While considerable acreage of open-pollinated corn varieties is grown in the United States, most Corn-Belt states have extensive corn-breeding projects under way. Already, hybrid corn varieties are grown in all corn areas and it appears that the time is not far distant when most, if not all, of our corn will be of the improved hybrid varieties.

Figure 34. A field of rank-growing fodder corn.

With the development of hybrid-corn varieties, it is hoped that varieties may be standardized more than was possible with the open-pollinated types. Farmers have learned to recognize the importance of adapted varieties and insist upon securing those strains suited to their particular conditions. The effect of this improvement in corn varieties has been to increase farm yields and to result in a greater production of sound corn. Studies have shown that the hybrid-corn varieties in general result in better quality of corn, grading higher on the market, and commanding a better price.

In Chapter X, *Agriculture II*, was listed a number of hybrid-corn varieties grown in the corn-producing states. It is impossible to present a complete list of hybrid varieties, as corn-breeding is advancing very rapidly and new hybrids are frequently released. The student of agriculture should become familiar with the varieties recommended for his state. Above all, he should avoid the purchase of varieties unadapted to his region. The tendency to grow a larger, later type of corn should be avoided, as it usually results in lower yields of poor-quality grain. It is better to harvest 40 bushels of sound corn than 50 bushels of immature, low-quality grain.

While some farmers produce their own hybrid seed, to do so is not justified in most cases. It is better to secure seed supplies from one who specializes in its production. With the great increase in hybrid seed corn, the cost is low enough to be reasonable in nearly every section.

Where open-pollinated corn is grown, sound mature ears should be gathered from normally maturing plants. For this reason the seed should be gathered before frost. If the grain is wet, it must be dried artificially. It may be dried with a special corn dryer or, where small quantities are harvested, the drying may be done with a brooder stove or in the kitchen attic. In every case, it is important that provision be made to permit the escape of moisture from the drying corn. It is sound to select considerably more seed corn than might naturally be needed, as there is always the possibility of having to replant the field. One may also have an opportunity to dispose of the surplus seed to a neighbor.

With hybrid corn, all seed may be saved regardless of size of ear or shape of seed. Following drying, the corn is shelled and graded to remove odd-shaped kernels which may interfere with proper planting. A germination test is essential, as germination may be impaired without the grower's knowledge. All these operations may be performed during the winter months, when the press of other work is not great.

Planting. Generally corn is planted after clover or grass, small grain, or corn. In each case, a good job of plowing is essential. In most sections the plowing is done in the fall and at a depth of about 5 inches. Experiments at the University of Illinois indicate that, when the added cost of deeper plowing is considered, plowing at greater depths does not pay. Where corn follows corn, the plowing is usually done in the spring. It is important that spring plowing be done as early as possible to permit the firming of the seed bed and the greatest possible decomposition of the organic matter plowed under. Where sweet clover is plowed under, spring plowing usually results in better destruction of the plants. Sweet clover plowed under in the fall may prove to be a troublesome weed. Cornstalks should be leveled to insure a good job of plowing. This leveling is effected by disking or, in rare cases, by using a stalk cutter.

Plowed land should be worked in the spring as often as necessary to destroy weeds. Every crop of weeds destroyed at this time means much better control of them later in the season. Spring-plowed land should be worked down before it has an opportunity to dry out. This extra preparation hastens the firming of the seed bed and encourages the germination of weed seeds.

The use of the tractor makes it possible for a farmer to farm much more land than is possible with horses. Figures prepared by the United States Department of Agriculture show the amount of work done in a 10-hour day by different methods of operation:

Plowing with horses:	Acres	Plowing with tractor:	Acres
Walking, 14-inch, 1 man, 2 horses	1.9	Two-plow	6.7
Sulky, 14-inch, 1 man, 4 horses	2.6	Three-plow	8.2
Gang, 24-inch, 1 man, 4 horses	4.1	Four-plow	10.4
Gang, 24-inch, 1 man, 6 horses	4.9		

Following plowing and disking, the land is smoothed with a harrow to prepare for planting. The common methods of planting are: (1) surface planting, (2) listing, and (3) furrow planting. Most of the planting in the Corn Belt is done by the surface method. In dry regions where moisture is a limiting factor listing is practiced. The furrow planting is a type of listing.

The check-row planter is most widely used. Not all corn is checked; it may also be planted in drill rows. The check method is preferred, as it makes possible cross-cultivation and better control of weeds. The common types of check-row planters are: (1) the edge-drop cumulative, (2) the flat-drop cumulative, and (3) the full-hill drop. Many farmers prefer the edge-drop planter, as it selects the kernels on the basis of their thickness. When the grain is properly graded, the kernels are usually more uniform in thickness than in width. Some, however, advocate the flat-hill drop. The hill-drop planter probably does not result in as even planting as the other two types. In each case it is important that the grain be graded and that the proper plates be selected. The planter plates should be checked by running preliminary tests on the barn floor. By blocking the wheels up, they may be turned and an accurate check made. Most farmers plant 3 to 4 kernels per hill. The smaller varieties of corn may be planted at a heavier rate. On highly fertile soils, the rates may be increased.

Corn is drilled on clean land where weeds are not serious. The rows are 3 to 3½ feet apart and the corn is dropped, so as to place a kernel every 10 to 14 inches. Where weeds are not serious, drilled corn yields fully as well as when checked. In most sections weeds are so serious that checking is advisable. Proper checking depends upon the ability of the operator to pull the wire always at the same tension. This operation can be learned only with practice. Checking is to be avoided on side hills where erosion may occur. Also, farmers using strip crops to control erosion must drill their corn.

In Kansas, Oklahoma, and neighboring states considerable corn is listed. The lister opens a series of furrows by means of a double moldboard plow. The lister planter places the kernels in the bottom of the furrows 3½ feet apart. As the corn grows, the soil is plowed into the furrow until the furrow is entirely filled and the surface is level.

The furrow opener has a pair of shovels or disks attached to the planter runner. The furrows are usually 3 to 4 inches in depth and the corn is dropped in the bottom of the opened furrow. The corn is usually checked, so as to permit cross-cultivation.

Corn is planted as soon as the ground is warm to insure maturity before frost. Most planting in the Corn Belt is done about the middle of May.

Tillage. Corn is cultivated to control weeds. Many believe that tillage saves moisture because of a soil mulch. This theory has proved to be incorrect. Excessive cultivation may do more harm than good. The practice of cultivating corn as many times as possible, even when free from weeds, is undesirable.

It is desirable to cultivate the seed bed in order to stimulate early weed growth. The field may be harrowed frequently before the corn emerges, to destroy many weeds before they are well established. Even after the corn plants are fairly large, 4 to 5 inches, the harrow may be used to destroy small weeds. The teeth are sloped to avoid injury to the corn plants. The advantage of this method lies in the rapidity with which a field may be cultivated. Many farmers use a rotary hoe for the early stages of corn cultivation.

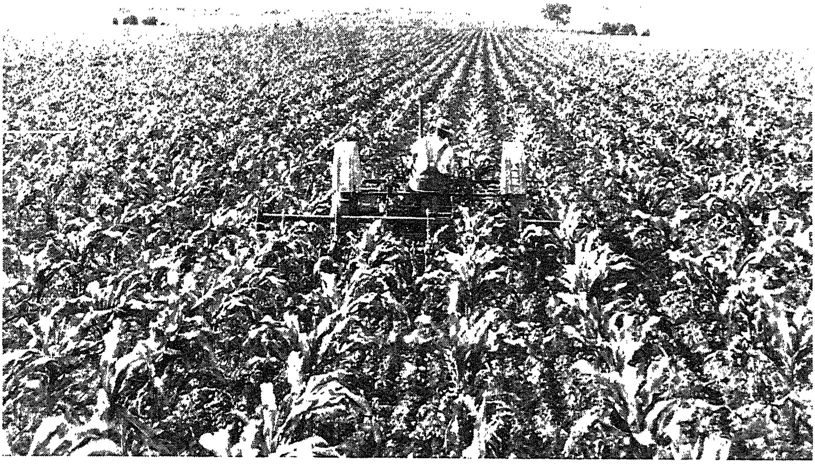


Figure 35. Power cultivation reduces the cost of producing corn.

Most corn is tilled with a corn cultivator. The first tillage should be deep and close to the plant. It is important that this implement be equipped with a sweep type of shovel for later cultivations. Much damage may be done to corn as a result of deep cultivation after the plants have developed their root systems. A month after corn is planted the roots may be very near the surface, so that plowing deeper than 3 inches close to the hill may cause much damage.

Listed corn is cultivated with a special disk cultivator. These disks throw the soil into the furrow until it is filled at the time of the last cultivation.

Rotation. The corn grower who wishes to maintain a high level of yields must give especial attention to the rotation followed. Proper rotations should be based on a long-time plan of operation. The short rotation so commonly followed leads to rapid depletion of fertility. The farsighted farmer plans a rotation not for 3 to 5 years but for 25 years or more. He must bear in mind that even the best of rotations deplete fertility. The application of sound principles will delay the day of reckoning and maintain fertility for a longer period. Some of the most common rotations in the Corn Belt are:

1. Corn continuously.
2. Corn, oats.
3. Corn, oats, clover.
4. Corn, corn, oats, clover.

Corn continuously and the corn and oat rotation are especially hard on fertility. Farmers have been able to follow these schemes only because the soil was very fertile at the start. Continued use of the rotation results in lowered yields, soil erosion, and general wearing-out of the soil. The Illinois Agricultural Experiment Station in its long-time rotation studies has shown that the inclusion of clover in the crop sequence aids greatly in maintaining crop yields. Even with the addition of clover to the rotation, fertility is depleted. Only properly inoculated legumes, as clover, can return nitrogen to the soil. If the clover crop is removed, no appreciable gain is made in nitrogen supply. In fact, even with clover, the nitrogen supply is reduced. The farmer who produces livestock returns the manure to the land and thus saves a part of the fertility. The average ton of manure contains about 10 pounds of nitrogen, 2 pounds of phosphorus, and 8 pounds of potassium. This manure is usually applied once in the rotation just ahead of corn, so that this crop may receive the greatest benefit. All plant residues, as cornstalks, straw, and weeds should be returned to the soil by proper plowing under to expedite decomposition. Most farms show a benefit from the addition of phosphorus-bearing fertilizers, and in some cases complete fertilizers carrying nitrogen and potassium in addition may prove beneficial. Fertilizers may be applied at the time of planting or at the time of cultivating corn for the first time, using attachments suited to the farm implements. At the Ohio Station the addition of 320 pounds of superphosphate with 8 tons of manure increased corn yields 6.2 bushels per acre.

Many farmers are coming to recognize that a longer type of rotation is desirable for permanent agriculture. The inclusion of alfalfa in the rotation permits the building of the soil and preparation for a bumper crop of corn. The alfalfa field is usually fall-plowed before planting to corn. Many Corn-Belt farmers can not grow alfalfa successfully without the addition of lime to correct soil acidity. In the southern part of the Corn Belt, lespedeza has become an important soil-building crop, as it will grow on soils too low in lime to support alfalfa or the clovers.

Harvesting. Corn may be harvested by several methods, depending upon the use to be made of the crop. The most common methods of harvesting are:

1. Husking ears from standing stalks.
2. Snapping ears from standing stalks.
3. Cutting the stalks for silage.
4. Cutting the stalks for shock fodder.
5. Using livestock to harvest crop.

In most of the Corn Belt, the greater part of the crop is harvested by husking the ears from standing stalks following frost and drying of the ears to not more than 25 per cent moisture. Most farmers husk by hand, using a peg or a hook. During recent years there has been a marked increase in the use of husking machines. Two-row husking machines may harvest as many as 30 acres per day. These machines enable the farmer to harvest his crop within a relatively short period. The machines are expensive, however, and the small grower can not justify their purchase. The mechanical husker does not operate successfully where the corn plants are lodged severely. The machine also knocks ears from the stalks. It is essential that these be gathered after harvest. Some farmers object to the harvester because it tears up the corn plants, making it impossible to use the stalk field for pasture. On large acreages the mechanical picker is here to stay and may be expected to gain in popularity.

Harvesting fodder corn is common in many sections, particularly in those areas where livestock is used to consume most of the feed produced on the farm. Many farmers plant at a heavier rate or use a later-maturing variety of corn for fodder. Harvest is started when the kernels are well dented and hard, and before the leaves have fallen. The plants are cut with a self-binder, by hand, or with a sled or platform cutter. The harvested bundles are placed in shocks for later feeding to livestock. Some farmers haul the bundles to the barn lot for convenience. The disadvantage of this method is that the corn is usually badly damaged by rats that are attracted to the pile. In some sections the ears are husked from the bundles and the stover reshocked to be fed later.

The shredder, once a popular machine, is used to husk the ears from bundle corn. The shredded stover may be blown into the barn for feeding and bedding. The practice is not as prevalent as in earlier years. It has been found to be a rather expensive method of harvesting.

The use of livestock to harvest corn is popular in many sections. Hogs are used for this purpose more than any other class of animals. Advocates of the method argue that it saves labor, reduces storage costs, and results in less waste. To avoid unnecessary waste it is essential that but a small area be fenced at a time, so as to confine the hogs until they have cleaned up the corn. If allowed too much area, more waste will result. It is desirable to provide tankage to supplement the corn fed, if best gains are to be made.

There are certain disadvantages. During wet weather the hogs waste considerable corn, and there is an added problem of fencing.

Some farmers use lambs in the cornfield to clean up the weeds and utilize the lower leaves. Care must be taken to prevent the animals from eating too much corn, especially when first placed in the field.

Storage. The harvested ears must be stored in cribs for further drying. As indicated above, the ears should contain not more than about 25 per cent of water at harvest time. The best cribs are relatively narrow, not more than 8 feet wide and constructed so as to permit air circulation. The slatted type of construction is popular in the Corn Belt. Too often the corn is stored in a makeshift structure made of slatted fencing or wire. Such storage results in great losses from the weather and rats and mice. When the corn has been dried so as to contain from 15 to 17 per cent of water, it may be shelled, and must be, if the corn is to be marketed. Where it is fed on the farm, shelling, under most conditions, is not essential.

In the South many farmers snap the ears from the stalks and store them with the husks attached. This practice reduces damage from storage insects in the crib. In the Corn Belt some corn is snapped in the early fall for feeding directly to livestock, but the practice is not general in this region.

The use of the silo has been popular in many sections, particularly among dairy farmers. The silo makes it possible for the farmer to utilize the full food value of the crop. It is likewise convenient to feed the silage with little or no waste. The feed is succulent and, it is claimed, aids in maintaining a good milk flow from dairy cows.

Two types of silos are available, the above-ground silo and the pit type. The above-ground silo is most common, being constructed of wood, tile, or concrete. The pit silo is used to some extent where a tight subsoil is available. It is prepared by hollowing a pit and filling it with the cut corn. Obviously, the pit requires much labor, especially to remove the silage at feeding time, and considerable loss occurs from spoilage.

Marketing. While many farmers feed their corn on the farm, millions of bushels are marketed each year. Marketing is especially prevalent in the Corn Belt on farms where livestock is not fed or not enough animals are fed to utilize the corn produced. Corn, like other commodities, fluctuates in price as the supply and demand shift. When a big crop is indicated by especially favorable reports, prices tend to fall. The rainfall and temperatures between July 1 and August 15 are especially significant as barometers of the probable crop. An early frost, following a wet fall, has a marked effect in lowering the total production and the quality of the crop.

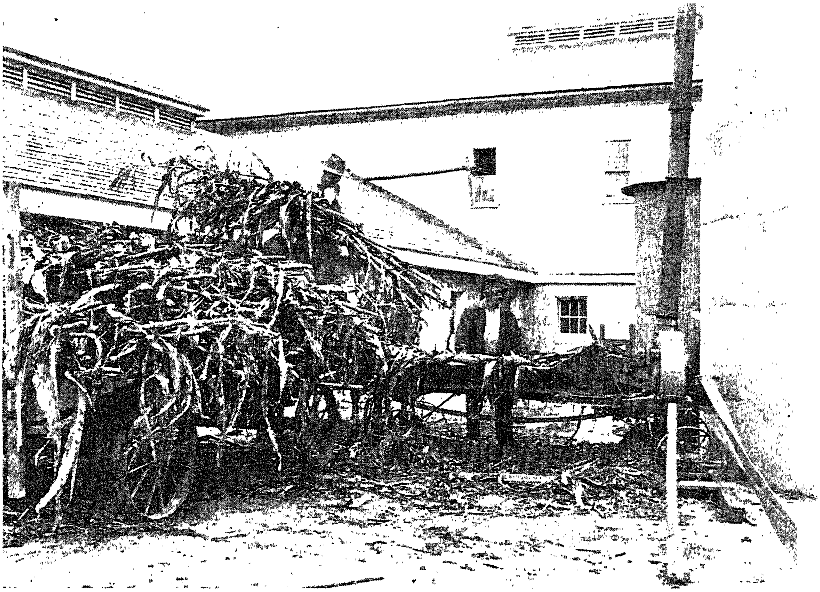


Figure 36. Filling a silo with freshly harvested corn.

As about 40 per cent of the corn crop is fed to hogs, there is a close relationship between hog and corn prices. The area of greatest concentration of hogs coincides rather closely with the area of corn production. The prices paid for pork vary with the economic situation. As business conditions improve, there is a corresponding increase in food prices. The effect of the economic unrest throughout the world has been to reduce our exports to foreign countries. As a result, prices have tended to be lowered as America has found herself with a surplus of both corn and hogs. The efforts of the government to meet this situation by regulating production and marketing are well known to nearly every one interested in agriculture and require no discussion here.

DISEASES

Several diseases attack the corn plant, but they rarely cause destruction of the crop. They rather reduce the stand or yield. Many farmers fail to recognize diseases which may be present.

Corn smut is one of the most common diseases. It is recognized by the black galls which develop on the corn plant. Breeding for resistance offers greatest possibilities. Rotation is of some value.

Seedling diseases are of importance in the Corn Belt. These may greatly reduce the stand of corn. Later, rots may affect the roots, stalks, and ears of the developing plant. A germination test may show their presence as their characteristic molds develop. The use of organic mercury dusts to treat the seed prior to planting is advisable. The cost is small and treatment may result in a much better stand of corn, especially in years of cool, wet weather favoring the development of the root rots.

INSECTS

Corn, like other crop plants, is attacked by many insects. Only the more important will be discussed here.

Wireworm. The wireworm is reddish-brown and about an inch in length. The adults are black or brown, about one half to three fourths of an inch long. The adult is frequently referred to as a click beetle because of the clicking noise it makes when placed on its back.

The wireworm feeds on the seed and later on the corn roots. Sickly plants frequently are suffering from attacks by this insect.

The best control of the wireworm lies in crop rotation. Fall plowing may prove of some value in destroying it.

Corn Rootworm. There are two types of this insect, the northern corn rootworm and the southern corn rootworm. Both these worms are small, slender, white grubs which feed on the roots of the corn plant. The northern adult is a small green beetle. The adult of the southern form is green also, but it has twelve black spots on its back. The northern form lives only on corn and may be controlled by rotation. The southern form lives on other crops and can not be controlled by rotation. Fall plowing will aid in its control.

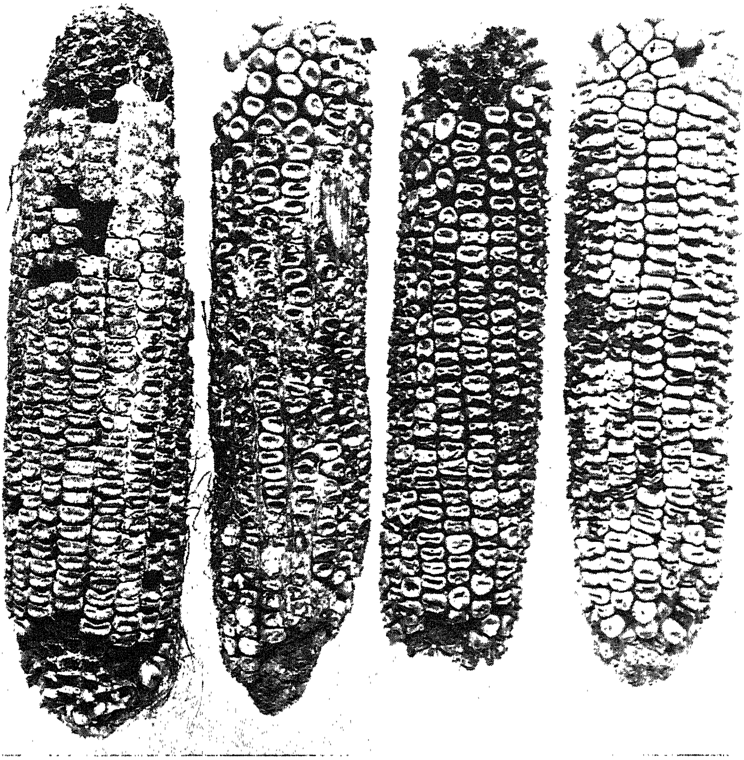


Figure 37. Ears of corn infected with disease.

Grubworm. The white grubworm is one of the most destructive corn insects. It is a grayish white grub with a brown head. The adult is a large brown beetle known as the May beetle or June bug. The grubs feed on the roots of the plant and may cause the complete destruction of the crop.

The grubworm may be controlled in some sections by proper crop rotation. As the insects require 3 years for their cycle, one may avoid corn on infested land or on sod where the grubs are prevalent. Early fall plowing aids in destroying the grubs.

Chinch Bug. This is one of the most destructive insects in the Corn Belt. The adult is small, about one fifth of an inch in length, with a peculiar x-shaped white mark on its wings. The crushed adults emit a foul odor which aids in their identification. The insects hibernate in grass along fences. In early summer they feed on fields of small grain. From the small grains, they migrate to the cornfields. The adult destroys the plants by sucking juices from the stem.

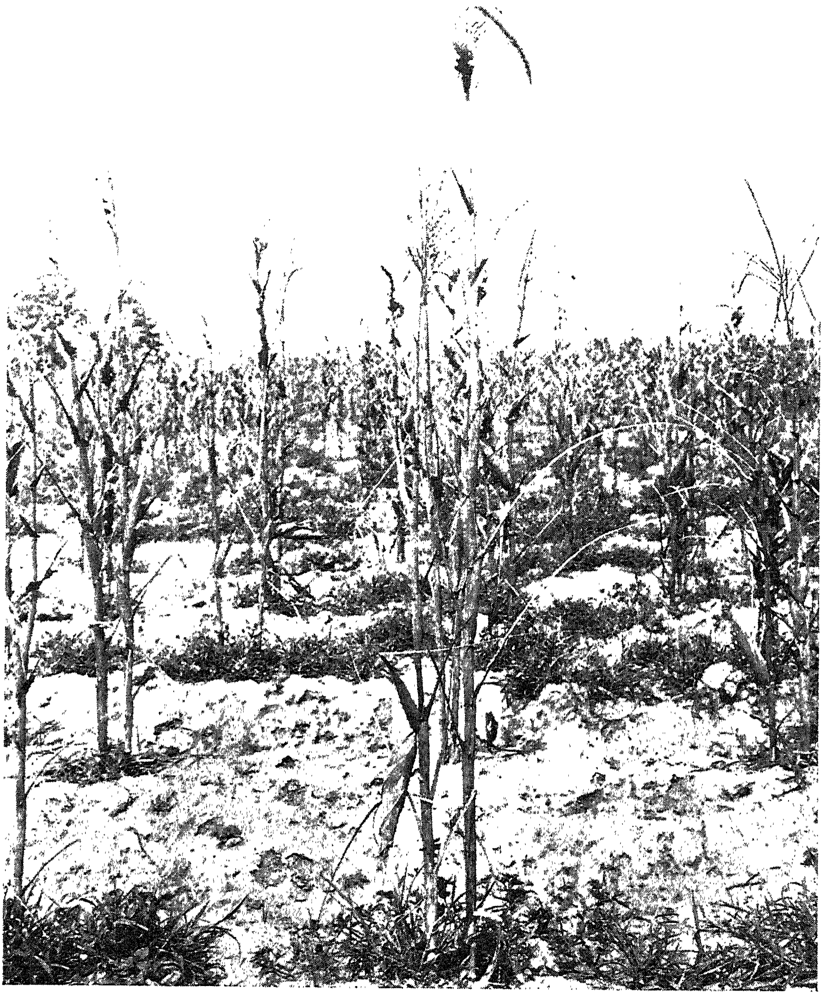


Figure 38. Grasshoppers may entirely defoliate the corn plant.

The best means of control lie in the destruction of hibernating places and the use of creosote barriers to prevent the insects from migrating from the small grain fields to the corn.

Corn-ear Worm. This is a very destructive insect. The adult is a green or brown worm that eats into the ears of corn. The brown adult moth lays its eggs in the silks. The young worms feed on the silks and tunnel down into the ear. As the ear is thus opened to the entrance of moisture, much of the damage is secondary to the actual destruction by the worm.

The corn-ear worm is not easily controlled. Fall plowing may be of some help. The development of corn varieties with tight-fitting husks appears to be a possibility of control.

European Corn Borer. This insect created great alarm when first found in this country. The larva which does the damage is a small light-colored worm with a row of small dark brown spots on each segment of its body. Several pinkish lines extend lengthwise of the body.

The European corn borer tunnels through all parts of the plant, causing great destruction. Best control lies in the plowing under of all infested vegetable matter. There is also promise in the development of resistant varieties.

Grasshoppers. The adult grasshopper, of which there are several species, is familiar to almost everyone. Several species are found in the different sections of the country. All damage crops by devouring the plant. In some cases, the entire corn crop is destroyed.

The grasshopper is best controlled by crop rotation and fall plowing. When the pests do appear, a poison bait should be placed along the edge of the cornfield. The bait may be made by mixing in the following proportions:

Bran or sawdust, 25 pounds.
Crude white arsenic, sodium arsenite, or Paris green, 1¼ lbs.
Cheap molasses, 2 quarts.
Water, 2½ gallons.

This combination makes enough bait for about two acres. The bait is poisonous to livestock.

PRODUCTION OF GRAIN SORGHUMS

The sorghum plant was brought to the United States within the past century. Since its introduction, it has spread rapidly, until it is now grown on some ten million acres annually.

Grain sorghum is grown largely in sections where rainfall is a limiting factor. The ability of sorghum to grow under fairly dry conditions has led to general use where its habit of growth is favorable. In these instances it serves the same purpose as corn. Along with the so-called grain types, we shall consider the varieties grown for forage. On many farms both types are grown.

The grain sorghums, such as kafir, milo, hegari, feterita, and darso are cultivated for grain to be fed to livestock and for stalks to provide fodder, stover, or silage. The sorgos are grown for forage or sorghum molasses, broomcorn for brooms, and Sudan grass as an emergency hay and pasture crop in drouth years in humid regions.

Where Grown. Sorghums are grown extensively in the Southwest. Kansas, Nebraska, Oklahoma, and Texas are the principal grain-producing states. Neighboring states and California and Arizona also are important producing centers of grain sorghums. The sweet sorghums, however, are not used for their grain. These types are grown throughout the Cotton Belt and in the grain-producing states of the Southwest. Broomcorn production is concentrated in Oklahoma, Illinois, and a few other sections. Sudan grass is suitable as an emergency crop during drouth years in the more humid areas.

It is general practice to grow grain and forage sorghums in those areas where insufficient rainfall is likely to make corn-growing a hazard. Where corn can be grown successfully it is generally preferred to sorghum. The forage types will be treated under the heading of forages.

Soil and Climatic Adaptations. Like corn, grain sorghums yield best on fertile loams well supplied with plant food. When grown in rotation, it is common to give them a preferred place.

Sorghum plants are especially superior to corn on thin or sandy soils. The sorghum plant is also fairly tolerant of considerable quantities of alkali in the soil. Some cotton soils of the Southwest become infested with root rots which attack a wide variety of crops. The sorghum plant is able to grow in these soils and offers a valuable alternative to the farmer whose soil is badly infested with root rot.

Sorghums are grown most extensively in areas where the rainfall is from 15 to 25 inches. In more humid areas, as in parts of southeastern Kansas and southeastern Missouri, grain sorghums are grown in preference to corn, as they outyield corn on shallow soils low in water-retaining power. Some farmers in the Southwest grow corn on their lower lands where moisture is more plentiful and sorghums on the drier uplands.

Sorghums will not grow without moisture. They have the ability to remain dormant during extended periods of drouth and to resume growth with the coming of rain. In this respect they have a decided advantage over corn.

As the plants are of tropical origin, they succeed best in the warmer regions. If the season is cold at the time of planting, growth is retarded greatly and a poor stand may result. Even the lightest frost will destroy the plants.

For the most part grain sorghums require a frost-free period of 150 days or more and an average July temperature of about 75° F. The crop may be grown farther north, where the season is shorter or cooler, but only for its forage. As far north as northern Iowa the plants may fail to produce seed within the available growing season. As they grow slowly during the cool weather of the early and late portions of the season, one can not expect mature growth within the minimum growing period.

Varieties. Here we shall consider the grain varieties of sorghums. According to J. H. Martin of the United States Department of Agriculture more than forty distinct varieties of grain sorghums are grown in the United States. The student confronted with this long list may be discouraged, and so a few of the more important varieties will be listed for his guidance. The varieties differ widely in time of maturity, height of plant, leafiness, juiciness of stalk, color of seed, and many other characters.

The kafirs have juicy, but not sweet, stalks, and long cylindrical heads. The seed colors are white, pink, or red. They may be grown as grain feed for livestock or for forage, as the stalks are leafy and juicy and cure into good roughage.

The principal variety of kafir is Blackhull. Other varieties of kafir are Red, Pink, Dawn, Dwarf, Reed, Sunrise, Bishop, Wonder, White, Rice, and Pearl. The Blackhull variety has white grains and black hulls, or chaff, from which it derives its name. Red kafir is a good forage variety, but is rather late in maturity. Pink kafir is medium early. It is grown in southern and western Kansas for forage to be fed in the bundle.

The milos have slightly juicy stalks and compact, bearded heads. The seeds are large and yellow or white. With the exception of Beaver, Wheatland, and Fargo, which are milo-kafir hybrids, all the milos tend to produce a recurved or goosenecked head.

The principal varieties of milo are Dwarf Yellow, Standard Yellow, Double Dwarf, Fargo, Beaver, Wheatland, and Sooner.

All varieties mature in about the same time except Sooner. This variety, because of its early maturity, is sometimes referred to as Sixty-Day milo. The Dwarf Yellow variety is second in importance to Blackhull kafir among the grain sorghums. It is probably the best all-around milo variety available. The varieties Double Dwarf, Beaver, and Wheatland are short, being but 1½ to 3 feet in height. They are grown primarily for harvesting with a combine. Wheatland and Beaver grow erect and stand up better than other milo varieties.

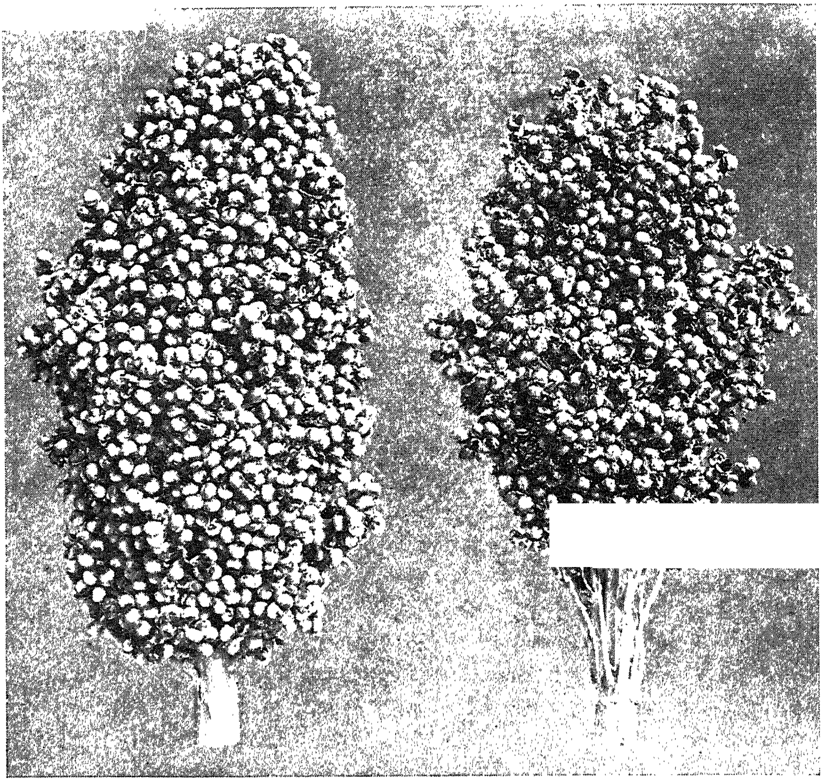


Figure 39. Dwarf yellow milo. Note oval shape of seed-head.

The feteritas produce plants with a dry stalk, erect, compact, oval heads and large bluish-white seed. The feteritas are early-maturing and may produce a crop in seasons of limited rainfall where the later-maturing kafir or milo fails. The early maturity makes possible the use of the crop for emergency seedings late in the summer. The principal varieties of feterita are Standard, Spur, and Dwarf. The leading variety is Standard. In Kansas, where it is most generally grown, Standard outyields other varieties of kafir. Spur feterita, a later-maturing variety, is grown extensively in Texas, where it was developed. Dwarf feterita resembles Spur, but is a shorter variety. It appears to have no advantage over the Spur variety.

The durra is a dry-stalk sorghum with a compact, bearded head and very flat kernels. The durras are not popular, as the grain shatters freely and the forage is of little value. In California Dwarf White durra is grown extensively.

Hegari is a grain sorghum with characteristics intermediate between those of kafir and feterita. The stalk is leafy and juicy. The seeds resemble those of kafir but have a bluish appearance due to a reddish-brown subseed coat. Hegari is grown in western and southern Texas, eastern New Mexico, and under irrigation in the Salt River Valley of Arizona. The crop is best suited for use as a fodder. The principal variety is Dwarf Hegari.

Shallu is a tall plant with dry stalks and few leaves. The kernels are small and white. Shallu is not grown extensively.

The kaoliangs produce plants with a dry stalk bearing few leaves. The heads frequently are loose, bearing small brown or white kernels. It is a variety of little importance.

Ajax produces thick, leafy, rather short plants. The heads are large and bear bluish white seeds. The variety is suited to the heavy soils of Texas and Oklahoma.

Darso is shorter than kafir with a juicy stalk. The erect, loose, open heads bear reddish-brown seeds. The seeds are bitter, making them rather unpalatable to livestock.

Schrock resembles kafir, except that it produces shorter and less compact heads with dark-brown kernels. Like darso, the kernels are bitter.

Kalo resulted from a natural cross between Pink kafir and Dwarf Yellow milo. The plants produce kafir-like heads and seeds of a pale yellow color. The stalks are not juicy, so the variety is not suited to forage use. An earlier-maturing variety known as Early Kalo is one of the most widely-grown grain sorghums in Nebraska.

Freed sorghum is a slender, few-leaved plant with sweet, juicy stalks. The erect heads are loose, bearded, and produce small white kernels. It is very early in maturity. Dwarf Freed is grown to some extent in western Kansas. Cheyenne, apparently a natural hybrid between Freed and kafir, is grown in northwestern Kansas and neighboring sections of Colorado and Nebraska.

Chiltex is somewhat intermediate between kafir and feterita. The stalks are dry like those of feterita. The heads resemble kafir and bear small, white seeds. It is grown in northern Texas and southern Oklahoma.

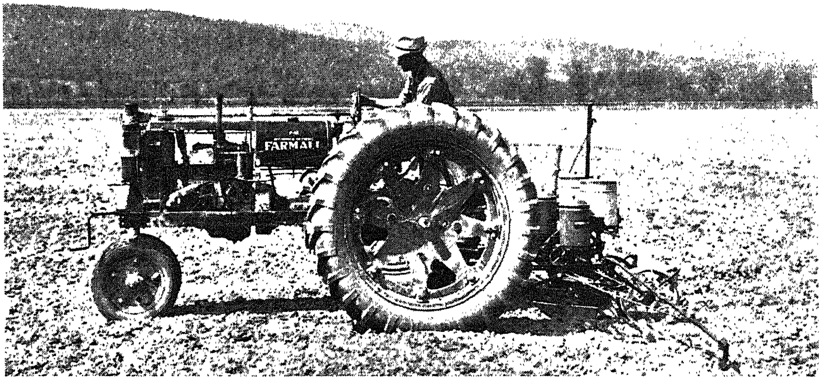


Figure 40. Using a corn planter to plant grain sorghum.

Premo resembles Chiltex except that it is later in maturity and produces more compact heads. It originated from the same cross as Chiltex.

Grohoma probably came from a cross between feterita and a sorgo. The stalks are dry like those of feterita, and the large, loose, beardless head bears brown kernels. This variety is less productive than kafir and milo under dry conditions.

As the grain sorghums cross readily, care should be taken to select pure seed. Varieties should be grown in isolated fields to prevent crossing. Natural hybrids may be recognized in most cases and should be removed from the field. Head selection in the field is essential to the maintenance of pure seed. The selected heads, gathered before frost, are dried and stored for next year's crop.

Planting. A good seed bed is essential for grain sorghums, especially in the conserving of necessary moisture. Cultivation prior to seeding destroys additional crops of weeds. The common method of preparation is to list or plow the land. Many farmers use a one-way plow.

Listing is rapid and aids in the prevention of soil blowing. On listed land the seed is planted in furrows, as was discussed earlier in this chapter. With both the lister and the corn planter, special sorghum-dropping plates are used. The size of the openings varies with the variety of sorghum. In very dry seasons, wide-spaced rows double the distance apart are advantageous. Most experiments show that the wide-spaced rows yield less grain on an average than the normal spacing of 36 to 44 inches.

Sorghum seeds are planted 1 to 2 inches deep at rates varying with the variety. The milos sucker freely and may be planted at a reduced rate. Kafir usually yields best when the plants are spaced about 6 inches apart in the row with rows 42 inches apart. This planting requires about 1¼ pounds of seed per acre. To allow for poor germination, it is usual to seed about 3 pounds per acre. Darso, Hegari, and Schrock are planted at about the same rate as kafir is. Milo yields best if the plants are spaced 1 to 2 feet apart in the row. Most farmers seed 1½ to 2½ pounds of milo per acre. Feterita, with its larger seed, is planted 3 to 4 pounds per acre. When the crop is grown for forage, thicker planting is desirable. Kafir, grown in rows for forage, is seeded at the rate of about 5 pounds of seed per acre.

Since sorghums prefer warm weather, planting is delayed until the soil is warm and cold nights are past.

Grain sorghum should be treated to prevent losses from smut and seed rots. The various dust treatments are satisfactory. The organic mercury dusts are available to all and provide cheap insurance against these diseases. Copper carbonate dust may be used in much the same manner.

Tillage. The sorghums are cultivated to control weeds. As weeds rob moisture from the soil, they are more serious in the low-rainfall sorghum areas than where corn is usually grown. For this reason, careful tillage is of added importance in the production of grain sorghums. Cultivation methods are much the same as with corn. The harrow may be used while the plants are small. Lister-planted sorghum is tilled with a lister cultivator, a machine adapted to furrow tillage.

Rotation. As a rule, the sorghum plant does not fit well into a rotation. It continues to grow until frost, and thus depletes the soil of moisture and interferes with the growth of the succeeding crop. The fibrous roots tend to cause the soil to plow up in large lumps not readily reduced into a good seed bed. Winter wheat, especially, shows a retarded growth when planted immediately after grain sorghums. While the causes are unknown, it is generally believed that the difficulty is due to a deficiency of available nitrates in the soil. Those micro-organisms stimulated by the carbohydrate residues from the sorghum roots are believed to utilize the nitrates for their own growth. This deleterious effect is largely overcome by a season of fallow in the dry areas or by the application of nitrogenous fertilizers, especially barnyard manure, in the irrigated sections.

In the Plains area, where wheat is the major crop, the sorghums are harvested too late for the proper seeding of wheat. Most farmers find that wheat yields under a system of continuous cropping are better than where the crop is rotated with grain sorghum. Those farmers who practice fallow may use a rotation of sorghum, fallow, and wheat.

Where cotton is grown as the principal crop, sorghums do not fit well into the rotation. Cotton grown after cotton will yield more than cotton following sorghum.

In northwestern Kansas many farmers grow spring barley following sorghum. Winter wheat is seeded in the fall, following the barley. If corn is grown, it may be used in the rotation between the grain sorghum and wheat. On land where winter wheat has failed as a result of winterkilling or drouth, sorghums may be seeded to advantage. In such instances the land is listed or disked before the crop is seeded.

In the southern Great Plains grain sorghums usually produce higher yields following fallow, winter grain, cowpeas, or cotton than where grown continuously. In the irrigated regions of Arizona and California grain sorghums follow fall-seeded small grains, either barley or wheat.

Harvesting. The grain sorghum is harvested when the seeds are fully colored and have begun to harden. If the combine is used, the grain must be allowed to become quite hard, as it will not keep in storage if it contains more than 14 per cent of moisture. The principal harvesting methods are:

1. Heading by hand.
2. Heading with machinery.
3. Self-binder.
4. Combine.

When the heads are removed by hand, a sharp knife is used to cut them off. They are then thrown into a wagon driven alongside. One man and a team can harvest about 1½ to 2 acres per day by hand. A machine header will cut 10 to 20 acres per day. The harvested heads are placed in piles to dry before threshing.

The row binder operates much the same as the corn binder. This method is especially desirable where the stover is to be used for feed. The harvested bundles are placed in shocks to dry and then threshed. This method is common in the central and eastern sections of Kansas and Oklahoma.

The combine-harvester is not suitable for many types of sorghum. The uneven ripening of many varieties is a problem for combine harvesting. The recent development of such varieties as Wheatland milo has made the combine more useful. This variety stands up and matures uniformly.

The grain separator is used to thresh headed or bundle sorghums. Usually, the sorghum bundles are topped, with only the heads fed into the threshing machine. As the seeds are cracked easily, the concaves of the threshing machine must be adjusted carefully to avoid damage. Where the grain is very dry, reducing the speed of the threshing-machine cylinder will aid in the prevention of injury.

Sometimes animals are poisoned by pasturing on sorgo and grain sorghums that have been stunted by drouth or other adverse conditions. The poisoning is due to the formation of deadly prussic acid. Losses may be largely avoided by not permitting the animals to graze wilted, stunted, or frosted plants. It is believed that the dangers may be avoided by harvesting the crop for hay, fodder, or silage.

Storing. The threshed grain is stored in tight grain bins the same as wheat or other grain. It is important that the bin be tight and that it be cleaned thoroughly to remove old, disease-infected grain. If this caution is not taken, the insects will soon attack the new grain and great damage may result.

When the grain is used for feed, it is fed during the season to livestock. The average grain sorghum compares favorably with dent corn. Corn contains more fat, while the sorghums contain more protein. In percentage of carbohydrates the two are nearly equal.

In some cases the farmer stores the unthreshed sorghum heads and feeds the entire heads whole or ground. As more space for storage is required, it is not advisable where large acreages are produced.

The grain sorghums may be used as forage in the form of stover or fodder. The more juicy varieties are best for this purpose. The crop is harvested as indicated earlier and is fed to cattle, horses, and sheep during the winter months, much as corn fodder is fed in the Corn Belt.

Sorghums may be made into silage much the same as corn. Harvested when the seeds are in the dough stage, grain-sorghum silage compares favorably with corn silage.

Marketing. The farmer who produces a surplus of sorghum grain may market the crop. United States Federal Grain Standards are established for the grain sorghums and they are sold according to grade. The price varies with supply and demand. Frequently, the price is influenced by the size of the corn crop, since the sorghum seed is used for much the same purpose. Where adequate storage facilities are available, it may prove advantageous to store the harvested crop to be marketed later rather than to sell at the time that the great bulk of the crop is being shipped to the terminal markets. The price of livestock will affect the demand made for grain sorghums in much the same manner as was outlined previously in the corn discussion.

Diseases. The principal diseases of the sorghums are kernel smut, red spot, and head smut. The kernel smut does much damage to grain sorghums, if seed treatment is not used. The organic mercury dusts are effective in controlling this disease. This disease is evidenced by the changing of the grains or kernels to a mass of dark-colored spores. The head smut is less common. This disease can not be controlled by seed treatment, as, like corn smut, it lives over in the soil. The use of seed from localities free from the disease and the destruction of diseased heads by burning will aid in its control.

Red spot, or sorghum blight, is recognized by red or purple spots which may elongate into streaks or stripes on the leaves. The destruction of the leaves reduces the efficiency of the plant and destroys valuable forage. The disease is most serious in warm, humid sections. No remedy other than the growing of resistant varieties is known. Leoti is the only commercially grown variety of sorgo that has proved resistant to this disease.

Insects. The principal insect pests of the grain sorghums are the sorghum midge and the host of pests which attack corn.

The sorghum midge is found in the southern states from central Texas eastward. Frequently its attacks prevent the profitable production of sorghum. The midge is a small fly with a red body. It lays its eggs in the hulls of the sorghum flower at blossoming time. A small white grub hatches from the egg and absorbs juices from the developing seed, thus preventing its formation.

The sorghum midge is controlled by very early planting to bring the plants into flower before the insects are plentiful. The destruction of Johnson grass, a host of the insect, will aid in its control.

The chinch bug is especially severe on the milos. This pest is controlled as outlined in the discussion of corn insects earlier in this chapter.

Suggestive Questions

1. Name the leading corn-producing states.
2. How does open-pollinated differ from hybrid corn?
3. When would it be advisable to drill corn?
4. What is meant by listing corn?
5. Under what conditions are grain sorghums preferable to corn?
6. How do grain sorghums compare with corn in feeding value?
7. What are the leading varieties of grain sorghums.

Suggestive Activities

1. Make a germination test of seed corn. Compare results with physical characteristics of ears.
2. Calibrate a corn planter to plant at the proper rate.
3. Make a map of the United States and locate the corn and grain sorghum areas.
4. Make a list of the various types of feed derived from corn, both grain and plant.

CHAPTER XIII

HAY AND FORAGE CROPS

A farm that produces livestock can not operate successfully without the production or purchase of considerable quantities of forage. Cattle, horses, and sheep require a large quantity of roughage along with the concentrates. Hogs may be fed entirely on concentrated feeds, but even this class of livestock benefits from access to pasture. It is difficult to draw sharp lines of distinction between different classes of feed. For example, corn may be used as a concentrate and as a forage. A hay meadow may be used a part of the time as a pasture. Here we shall restrict our discussion to the hay crops, as pastures both permanent and temporary will be discussed in the next chapter.

We have already considered corn and the sorghums both of which serve as valuable forage crops and, therefore, will not repeat their treatment.

HAY

Hay is the above-ground parts of the finer-stemmed grasses, legumes, or other forage plants, harvested and dried for feeding to livestock.

Where Grown. Hay or forage is grown wherever agricultural land is found. Regardless of the soil type and climatic conditions, except in desert areas, some type of hay or forage can be grown. In the more humid sections of the country, especially in the Northeast, there is a great belt of timothy and similar grasses. Along with timothy and other true grasses it is common practice to seed alsike or red clover. Timothy mixtures with these clovers are popular. Redtop also is well suited to this section. In the region of the Corn Belt, red and alsike clover, sweet clover, and alfalfa are commonly grown. In the southern part of the Corn Belt and in the South, lespedeza, Bermuda grass, and Johnson grass are important. In the Great Plains area and in most of the region west of the Mississippi River, alfalfa is the leading hay crop. Because of the ability of this plant to succeed under conditions of relatively low rainfall, it has been of especial value in these areas. Alfalfa-growing is restricted to soils possessing an abundance of lime. In the East, along the Atlantic seaboard crimson clover is an important hay crop. In the North Central states alfalfa-brome grass mixtures are becoming more and more popular.

Many annual hay crops are available in the more humid areas of the country. The soybean is grown in nearly every state both for hay and grain. In the South, the cowpea and velvet bean are adapted and provide large quantities of forage. The millets are used in parts of the South and in the western Corn Belt as hay crops. The millets are not as popular as most other hay crops, since they are not so suitable for all classes of livestock.

Because of the great differences between the hay and forage crop plants they will be discussed separately.

HAY AND PASTURE CROPS

The most important group of hay plants comprises those classed as biennial or perennial, that is, plants that live two or more years and usually occupy those periods of time in the rotation. Alfalfa, for example, may be left five to ten years or even longer in sections where it is especially adapted. The biennial clovers usually occupy the land one and a half years, that is, they are seeded with a grain crop and normally make their undisturbed growth after the grain is removed. Then the clover occupies the field the second year. The perennial and biennial crops will be discussed first. Then we shall consider the annuals.

TIMOTHY

Timothy is one of our most widely-grown hay and pasture plants. It is without question the most important grass-hay plant in this country.

Adaptation. This grass is a cool-weather plant and does not yield well south of latitude 36° except where it is grown at higher altitudes. It is capable of withstanding cold, rigorous winters, but fails under the warm, humid conditions of the South. An abundance of moisture is essential to its growth.

Varieties. Ordinarily, timothy is not sold by variety name. Some improved strains have been developed, particularly Shelby, Marietta, and Cornell 4059. Huron is a variety suited to the Pacific Northwest. Pure seed of high viability is essential to good stands and purity and germination tests should be made before the crop is seeded.

Growing. The seeds of timothy are small and must not be planted too deep. Seeding is usually done in combination with another crop, as a small grain. Where it is seeded alone, a well-prepared seed bed is essential. About 8 to 10 pounds of seed are sown to each acre. The more common practice is to seed timothy in combination with other grasses or legumes. In mixtures about 4 to 6 pounds of seed are sufficient. Except in the northern states, timothy may be seeded with winter wheat in the fall. In the North it is seeded with spring-sown grains. The seed is applied either with a drill attachment or broadcast over the surface after the grain crop has been seeded. A very light covering with a harrow is best to avoid too deep seeding.

The crop will do well on a variety of soils; but, because of its lack of ability to withstand drouth, it should not be seeded on light or sandy soils. Once established, the plant persists in regions where adapted. It will grow on soils too low in content of lime to permit successful alfalfa production.

Rotation. Timothy fits into many rotations. In the region where it is most commonly grown it is usually seeded with a grain crop. A common rotation is (1) corn, oats, timothy, or (2) corn, oats, clover, timothy. In the latter rotation a timothy and clover mixture is seeded. In the fourth year of the second rotation the timothy has replaced the clover. If desired, the crop may be grown for five or more years, using it for hay or pasture or both. It is usually best, however, to use a shorter rotation. The combination of clover and timothy makes a better quality of hay. Either alsike or medium red clover may be used to advantage depending upon their adaptation.

Harvesting. Most timothy is harvested for hay. The crop should be cut just after flowering. Some growers prefer to wait until the blossoms have fallen, thus avoiding the dusty condition produced by the flower parts. While higher yields may be obtained by later harvests, the quality of the hay is lowered as the percentage of crude fiber increases.

For hay it is common to harvest the crop by cutting it with a mower. After drying, the hay is stored in barns or stacks. Yields of 1 to 2 tons per acre are average. If the crop is to be harvested for seed, it is left until the seeds are in the dough stage. A grain binder is used and the harvested bundles are placed in shocks to dry. Threshing is done with a grain threshing machine. Yields of 7 to 10 bushels per acre may be expected under favorable conditions.

Storage and Marketing. As indicated above, timothy hay is stored in barns or stacks. Where space is available, the barn is preferred, as it avoids much of the waste resulting from stacking. Where stacks are used, they should be built carefully, so as to shed water. Even under favorable circumstances spoilage results if hay is placed in stacks. The hay may be fed or marketed directly from the stack. The market for timothy hay has decreased greatly with the decreased use of horses.

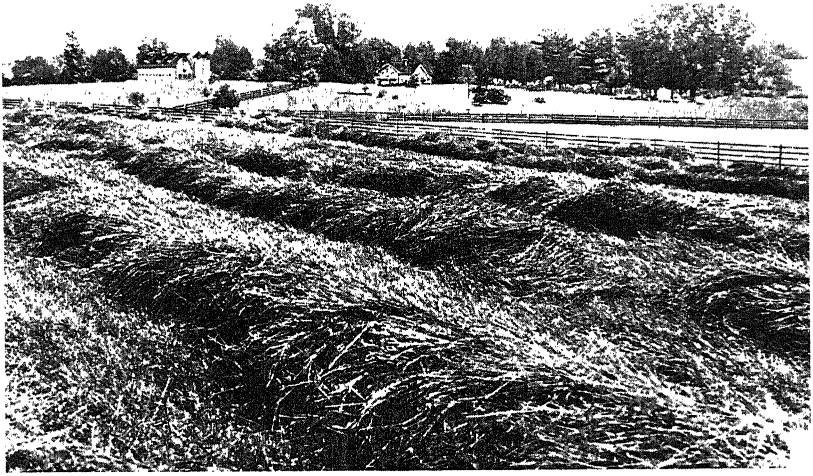


Figure 41. A heavy crop of timothy hay in the windrow.

Uses. Timothy is grown for hay either alone or in combination with other grasses and legumes. In addition to use as hay, timothy makes a satisfactory pasture crop. Many farmers make a practice of using timothy for both hay and pasture.

REDTOP

Redtop is a widely-grown hay and pasture grass found in most parts of the United States, except where it is very dry or where high temperatures prevail.

Adaptation. This crop, like timothy, prefers cool, moist conditions. Under these conditions it will succeed on almost any type of soil. The plants will withstand great cold and succeed as far north as Alaska. Because of its preference for moist soils, redtop does well in low, wet, poorly-drained meadows and pastures.

Growing. The small, light-weight seeds require a firm seed bed. About 5 to 8 pounds of seed are sufficient for an acre. When sown in mixtures, probably 4 to 6 pounds are ample in most cases. It is seeded in the same manner as timothy.

Rotation. Redtop is rarely seeded in meadows as a single crop. Usually, it is a part of a grass and legume mixture. The plant is rather widely distributed and it tends to become established naturally in regions where it is adapted. Its growth habits make it more suited as pasture than as hay.

Harvesting. The only place where redtop is usually grown for hay is in low wet meadows where other hay crops are unadapted. The crop is harvested before seeds are formed. Much the same methods that are used in harvesting timothy are employed. Yields are not high, about 1.0 to 1.5 tons being average. Harvesting for seed is profitable in some sections. The seed is generally harvested with strippers. The crop may be harvested with a binder or mower the same as timothy. As the seeds are very light in weight, the threshing machine must be operated at a greatly reduced speed.

KENTUCKY BLUEGRASS

The bluegrasses are used almost entirely for pasture purposes, and without doubt Kentucky bluegrass is the most valuable pasture crop on many farms.

Adaptation. Bluegrass is suited to a wide variety of climatic conditions. It is cold-resistant and withstands hot weather. During hot weather, however, it enters into a period of dormancy from which it emerges with the coming of cooler, moist weather. While it withstands periods of drouth, it is not a dry-weather plant but does best under conditions of ample rainfall. Kentucky bluegrass does not succeed on poorly-drained soils. Its ability to withstand fairly-close cutting has made it one of the most popular lawn grasses in the North.

Growing. As with other small-seeded grasses, a firm well-prepared seed bed is essential. The crop is usually seeded in combination with other grasses and legumes and from 5 to 15 pounds per acre seeded, depending upon the mixture. When seeded alone it is best to use 20 to 40 pounds per acre. The very light-weight seed is variable in germinating qualities and it is desirable to seed sufficiently heavy to insure a good stand. When planted with other crops, where adapted, bluegrass gradually replaces the other plants and tends to become a pure stand. It may be seeded either in the fall or spring during the cool part of the season. If the grass is used on a lawn, the grower can afford to seed at a much heavier rate to insure a good stand within a shorter period.

Harvesting. As most bluegrass is used for pasture, harvesting is not a problem, except that overgrazing must be avoided. For commercial seed production it is common to use rotary strippers to pull the seed parts from the plants. These are spread to dry and threshed with a machine operated at a slow speed and with a reduced air blast. It is not uncommon to secure yields of 15 to 25 bushels of seed per acre.

CANADA BLUEGRASS

This grass resembles Kentucky bluegrass in many respects. It is somewhat better adapted to soils of low fertility and inadequate moisture supply than Kentucky bluegrass. It is not as desirable as the Kentucky bluegrass, because the quality of the forage is inferior.

SMOOTH BROME GRASS

This is an important grass in the northern states. It has become of increasing importance during recent years, as growers have come to know its adaptability to widely differing conditions.

Adaptation. This crop is able to succeed with a limited moisture supply. Its drouth resistance has led to its increased use in regions of low rainfall. While it prefers fertile soils, brome grass is probably superior to any other cultivated grass in yielding ability on dry, light soils. It is extremely cold-resistant, succeeding in all parts of the United States. As might be expected from its drouth resistance, it suffers in a moist, humid area.

Growing. The grass is usually seeded with small grains. The seeds are light in weight and from 10 to 20 pounds per acre should be used. It is common to use brome grass in mixtures with other crops. About 5 to 6 pounds are sufficient for most mixtures. It is difficult to broadcast the seed because of its very light weight. Fortunately, unlike most of the small grass seeds, it can be planted fairly deep, as the young seedlings have the ability to push through the soil. A drill may be used provided a firm, well-prepared seed bed is available.

Harvesting. Brome grass makes best hay if harvested when in full bloom. Under most conditions two cuttings may be made within a year. Recently it has become popular to seed brome grass with alfalfa. The grass is able to resist the frequent cuttings and adds to the palatability and quality of the hay.

For seed production brome grass is harvested when the heads turn brown. An ordinary binder or a header may be used to advantage. The crop is usually cut high and the stubble utilized for hay. Threshing is done with a regular threshing machine, observing the usual precautions necessary with light-weight seeds. Yields of 300 to 500 pounds of seed per acre are not uncommon. Where pure seed, free from quack grass, can be produced, it is likely to prove a profitable crop.

CRESTED WHEAT GRASS

This plant was introduced into this country during recent years. It has received considerable publicity and rather extravagant claims have been made regarding its values.

Crested wheat grass is a long-lived perennial especially suited to conditions of low temperature and rainfall. Apparently the crop will not yield well under humid conditions and its use appears to be limited to the northern Great Plains area.

Seedings are made in the spring at rates of 10 to 20 pounds per acre. The plant may be used either for hay or pasture, but its principal value is likely to be as a pasture crop.

REED CANARY GRASS

This grass, because of its ability to grow under very wet soil conditions, has become of great importance in the north central and northwest states.

Adaptation. Although this crop is especially suited to cool, moist climates, it does succeed in the Corn Belt. In states where peat or muck soils are prevalent, it has unusual possibilities as an important hay and pasture grass. The plant has the ability to withstand rather prolonged periods of flooding in the spring. Probably no other economic grass crop can grow under such widely varying conditions. While suited to wet soils, Reed Canary grows well when it is fairly dry. On upland and drier soils, however, other hay and pasture crops of higher yielding ability and superior qualities are available.

Growing. When it is possible to work the soil, it should be prepared as any other seed bed, making certain that it is compact. As much of the crop is grown on peaty soils, the need of compaction must be emphasized. Many of the wet areas are dry enough to work only during late summer. Under these conditions the crop is seeded alone at that time, using 4 to 6 pounds of tested seed. Where the soil can be worked in the spring the crop may be planted alone or in combination with grain crops. The use of pieces of Reed Canary sod is sometimes made to secure a stand.

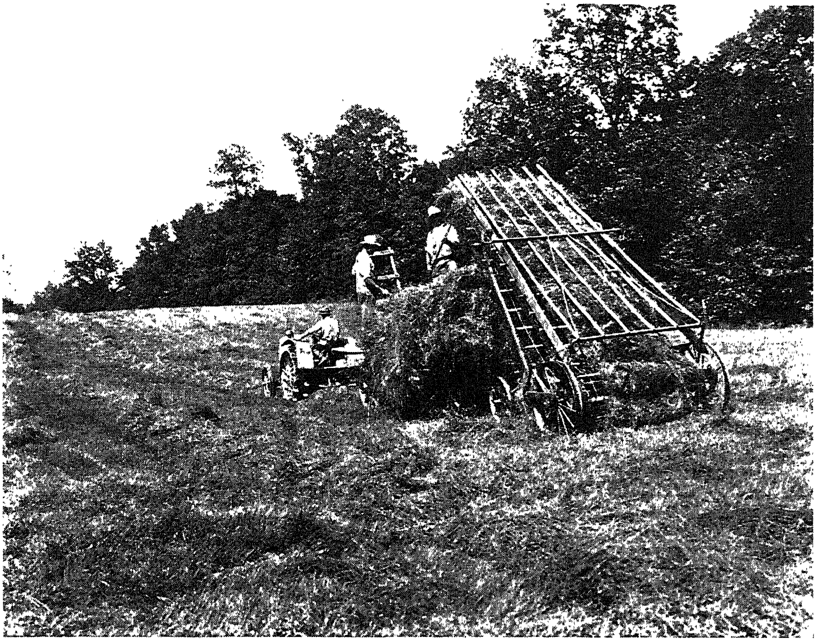


Figure 42. The hay loader speeds up haying operations.

This method, however, is slow and expensive under most conditions. This grass makes a desirable mixture for pastures and meadows that may have low areas not suitable for general grasses and legumes.

Harvesting. For hay Reed Canary grass is very satisfactory. The young plants are very nutritious with a high percentage of protein. The hay crop is made when the plants have formed heads. Cutting at this time makes it possible to secure about three cuttings per season. Naturally the later cuttings will be of finer quality growth and yield superior hay. The hay is palatable to all classes of livestock and is very popular in sections where it is grown. Yields of 3 to 4 tons per acre are not uncommon.

In recent years Reed Canary grass seed production has proved profitable, as the demand for seed has been high. The seed is difficult to harvest, because it matures unevenly. It is harvested when the upper panicles become gray or brown. By hand stripping it is possible to secure several harvests and thus obtain good yields on a larger scale. The upper parts of the panicles are gathered by heading them. These panicles will be full of moisture and must be dried carefully to avoid heating and loss of viability.

Uses. The Reed Canary crop may be used for pasture or hay or both. Some growers take off the first crop and pasture the second and third crops.

ORCHARD GRASS

Orchard grass is an introduced grass that was brought to this country from Europe.

Adaptation. This plant is adapted to a wide range of conditions. It tends to replace timothy in the middle latitudes of the eastern half of the United States, as it is more resistant to heat than timothy. Kentucky, southern Indiana, and adjacent states provide conditions favorable to orchard grass. As it prefers a fair amount of moisture, it will not do well on light soils. Its ability to succeed under shade has led to its name. Its tendency to grow in dense bunches makes it unpopular with some farmers.

Growing. The crop is grown much the same as timothy except for region of adaptation. From 10 to 20 pounds of seed are required for an acre. The crop is cut for hay when in the full-bloom stage. As a pasture crop it is usually planted in a mixture. For seed the crop is harvested with a binder when the seeds are well formed. The usual precautions in threshing light-weight seed are necessary.

MEADOW FESCUE

Meadow fescue is especially important in Kansas and Nebraska where it is more successful than timothy as a hay crop. The crop was introduced into America from Europe where it is grown rather extensively. Growth starts early in the spring and continues until late in the fall.

Adaptation. This plant is adapted to much the same area as timothy. It is somewhat more resistant to heat and drouth than timothy. Where timothy is adapted, as in the northeastern quarter of the United States, it has been far more popular than meadow fescue.

Seeding. The crop is seeded at the rates of 25 to 30 pounds per acre on a well-prepared and firm seed bed. Either fall or spring seedings are successful, sown alone on clean land or with a companion crop. Where the crop is grown for seed a lighter rate of seeding may be used.

Harvesting. Grown for hay, it is harvested as it comes into bloom. Under best conditions it may produce two tons per acre. Where it is well adapted and moisture is abundant, two cuttings are possible.

Uses. Meadow fescue is as palatable as timothy or bluegrass, and may be used either for hay or pasture, but it is more popular for pasture than for hay. Many growers use it in a mixture with other grasses and legumes.

PERENNIAL RYE GRASS

This plant, a native of Europe, was introduced into America, where it has not become of great importance except as a mixture with other grasses.

Adaptation. Perennial rye grass is a short-lived perennial adapted to moist sections with mild winters. It prefers rich, well-drained soils and usually fails when seeded on light or sandy types. It is also unsuited to soils which are wet.

Seeding. The seeds of perennial rye grass are very light. Seeding, therefore, should be fairly heavy. From 25 to 35 pounds are best for individual sowing. Where it is a part of a mixture, from 5 to 10 pounds are usually sufficient. The seed bed is prepared as for other grasses. In the North, seedings should be made in the spring; in the South, late-summer or early-fall seedings are satisfactory. Hay yields are likely to be low in comparison with other hay crops.

Growing. This crop is secondary to timothy. Most of it is grown as an ingredient in lawn and pasture seedings. It is especially valuable in lawn mixtures, as it starts early to form a shade for the slower-growing, more permanent grasses. By the time these are established the perennial rye grass usually disappears. Probably most growers, where this crop is adapted, will find it more suitable for pasture than for hay.

CARPET GRASS

This typically southern grass is sometimes known as Louisiana grass. Its creeping habit, forming a dense carpet-like mat, is responsible for its name. The compressed, 2-edged creeping stems, rooting at each joint, and the blunt leaf tips are characteristic of the plant. Carpet grass, a native of the West Indies, was introduced into the United States early in the nineteenth century.

Adaptation. This grass is adapted to a warm climate. It is especially suited to sandy or sandy loam soils, particularly if moisture is near the surface. It is grown rather extensively in the coastal plains region from southern Virginia to Texas. Carpet grass must have plenty of heat and moisture for its best growth. Cool weather retards its growth greatly.

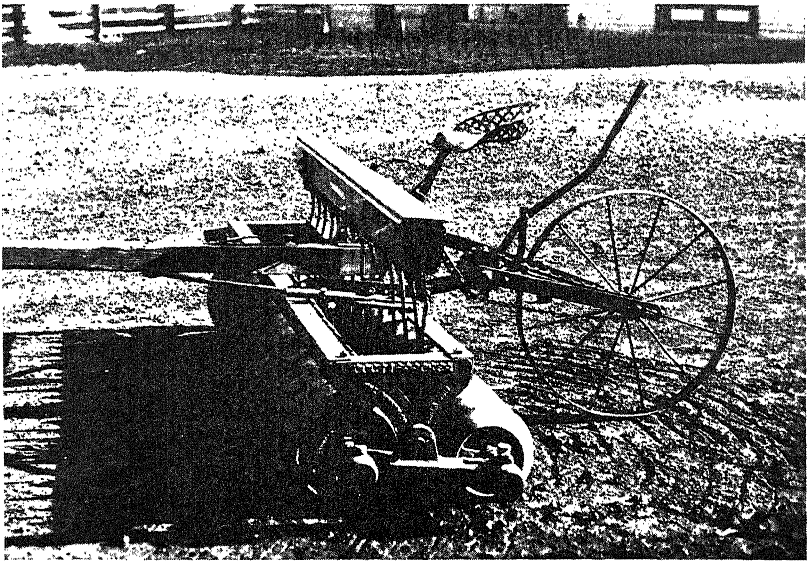


Figure 43. Double corrugated roller seeder as developed by the University of Wisconsin.

Growing. The crop is seeded either in the fall or spring. From 5 to 10 pounds of seed are sufficient for an acre. Some farmers seed it in combination with lespedeza, thus producing a valuable, nutritious pasture. The crop is used for pasture, as it rarely grows more than one foot high. The herbage is comparable with that provided by bluegrass, about one cow to an acre being the carrying capacity of the average pasture.

BERMUDA GRASS

This is the principal pasture grass of the South. Once established, it is difficult to control, and is considered undesirable in some areas.

Adaptation. Bermuda grass is suited to the warm sections of the United States ranging as far north as Maryland and Kansas. It does best on heavy types of soil, but may grow well on sand, if moisture is plentiful. On the drier, sandy soils, carpet grass is better adapted. The plant spreads by large, white, underground, jointed stems or root stocks and leafy creeping stems or stolons on the surface.

Growing. Like all grasses, Bermuda requires a firm seed bed. From 5 to 10 pounds of seed are required for each acre. As seed is scarce, plantings may be made by scattering pieces of the rootstocks or stolons over the surface of a good seed bed.

While Bermuda grass may produce fair yields of hay, it is best suited to pastures and as a basic lawn plant in the South.

THE LEGUMES

As a rule, the legume hay and pasture crops are more valuable than the grasses, since they provide feed rich in protein. Under proper growing conditions, they increase the nitrogen content of the soil as a result of the symbiotic nitrogen bacteria living on the roots of the legume plant.

ALFALFA

This is the most important legume forage in the United States. Wherever it can be grown successfully, alfalfa is a leading crop. Its growth has been of such benefit that it has been referred to as the "farm mortgage lifter."

Adaptation. Alfalfa is adapted to a large part of the United States. It will withstand both high and low temperatures. Excessive humidity together with high temperatures are unfavorable to the crop. Where the humidity is low, alfalfa grows successfully in spite of heat. Generally speaking, it is a semi-arid plant. If the soil is wet, alfalfa will not succeed. Low temperatures are withstood by more hardy varieties. Winter injury varies greatly with the moisture conditions in the fall and the presence or absence of protective snow covering.

Almost any well-drained soil will support alfalfa growth, except as indicated above. It is necessary that the soil be supplied with calcium, as alfalfa will not succeed on acid soils regardless of other conditions. Rather low-grade, sandy soils may produce good crops, if lime is supplied.

Varieties. The varieties of alfalfa were discussed fully in Chapter XII, *Agriculture II*. Here, we will repeat the more important varieties for review:

Common varieties—not hardy.

Variegated varieties—hardy.

The principal hardy varieties are Grimm, Cossack, Hardigan, Ladak, and Hardistan.

In the section where winters are not severe the common varieties may be grown. In the North, where cold winter temperatures prevail, the variegated hardy types are best.

Seeding. The method of seeding will differ with the adaptation. Where alfalfa is easily grown the crop may be seeded with a companion crop. It may be best to plant the grain at a reduced rate. If weeds are a problem or moisture is a limiting factor, it is advisable to seed the crop alone on a seed bed that has been prepared by a period of fallow. Seeding on a firm seed bed in the middle of the summer is best where seedings are difficult to establish.

Recently alfalfa and brome grass mixtures have shown promise in the northern Great Plains. The use of 5 to 10 pounds of brome grass and 5 to 8 pounds of alfalfa is a desirable mixture for hay or pasture.

Growing. Assuming that the soil is supplied with lime and well drained, we shall consider seeding problems. The drier the region, the less the seed required. Rates vary from 4 to 10 pounds in the dry sections, 10 to 15 pounds in the East and 20 to 25 pounds in the South. Where irrigation is practiced rates range from 15 to 20 pounds.

Rotation. The use of alfalfa in the rotation is not simple, as the crop may survive for several years. Under most conditions alfalfa may be expected to grow from five to fifteen years without reseeding. In order to establish a suitable rotation it may be necessary to set up two rotations. For example, with a five-field system a typical plan would be:

Field 1. Alfalfa, alfalfa, alfalfa, alfalfa, alfalfa, corn.
Field 2. Corn, corn, oats, clover, corn, barley.
Field 3. Oats, clover, corn, corn, barley, alfalfa.
Field 4. Clover, corn, corn, barley, clover, corn.
Field 5. Corn, oats, clover, corn, corn, oats.

This plan may be modified to suit the local crops grown. According to the plan above the alfalfa is rotated from field to field. To complete the rotation requires a total of about thirty years. It is apparent to the student that no rotation can be followed exactly as planned, for crop failures may interfere. When alfalfa is grown for several years the program must be modified and the basic principles should be carried out.

As alfalfa generally leaves the soil in a good condition of fertility, it is usual to follow it with a heavy-feeding cash crop, such as corn. The mere growing of alfalfa can not be expected to care for fertility needs. At the best, alfalfa harvested as hay probably maintains the nitrogen supply. The return of manures aids greatly, but it is necessary sooner or later to apply commercial fertilizers or farm manures to replenish depleted phosphorus, potassium, and calcium.

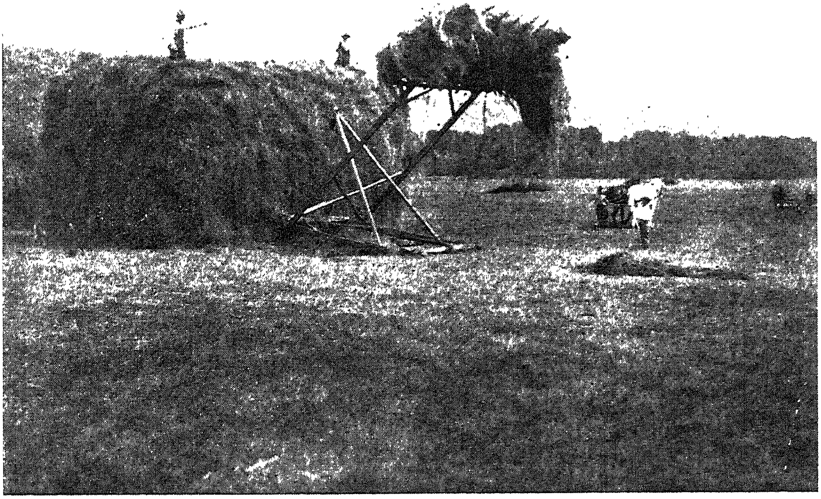


Figure 44. A common style of overshot stacker which is widely used. Two or three sweep rakes can be used with this outfit.

Harvesting. Alfalfa is cut for hay when as few as one tenth of the plants are in flower or when the plants start new shoots from the base of the crown. In the latter case, cutting is necessary where alfalfa does not bloom freely. From 2 to 5 or more cuttings per season are possible according to location. It is important that the last cutting be made early enough to permit 8 to 10 inches of fall growth before the coming of cold weather. This last cutting enables the plants to prepare for winter, and the top growth will aid in the holding of possible snowfall.

For a seed crop the plants are harvested when about two thirds of the seed pods have turned brown. The harvested crop is permitted to dry before it is threshed. Where seed can be grown, its production is likely to be profitable.

Pasture. Alfalfa may be used as pasture for all classes of livestock. There is some danger from bloat when cattle and sheep are pastured on it. Apparently, the danger is reduced by not permitting the animals to graze when very hungry or when the plants are wet with rain or dew. The addition of grasses, as brome in the North or orchard grass in the South, will aid in preventing bloat. Kentucky bluegrass should not be added, as it tends to replace the alfalfa.

SWEET CLOVER

From rating as an undesirable weed, sweet clover has risen in rank until it is now one of our most important forage crops. Where it is adapted, most farmers regard it as one of the best crops for adding nitrogen and organic matter to the soil.

Adaptation. Sweet clover may be grown in almost every state provided the land is not acid and sufficient moisture is available for the growing of ordinary farm crops. It is distributed widely from north to south and from east to west. It has unusual ability to grow under dry conditions, as its long tap root extends deep into the soil. It is better adapted to a wide range of soil types than either alfalfa or red clover. It will grow well under both warm and cool temperature conditions. In fact, sweet clover occurs naturally over a large part of the United States.

Varieties. The principal types of sweet clover are Biennial White and Biennial Yellow. Other types are being studied experimentally, but these are most important. Most growers prefer the Biennial White. Representative varieties are Common and Grundy County. Small-growing dwarf types, known as Alpha sweet clovers, have attracted considerable attention during recent years. Some growers prefer the Biennial Yellow for pasture, as it generally produces a fine leaf and stem growth. Annual White, or Hubam, completes its growth within one year. In Iowa it is grown as a soil-improving or quick-maturing pasture crop. The annual yellow variety is of little importance, except in certain areas of the South and in California, where it is grown as a winter cover crop in some orchards.

Seeding. Sweet clover may be seeded alone on a specially prepared seed bed or, more commonly, planted with a small-grain crop. As the plants are easily established, any small grain may be used. Spring seeding is best under most conditions.

As the seeds may be hard, it is important that a germination test be made before planting. Hard seeds with impervious seed coats may be remedied by scarification, a process of lightly scratching the seed coat to permit the entrance of water at planting time.

From 10 to 20 pounds of seed are sufficient under average conditions. The rate of seeding increases with the unfavorableness of the seeding conditions. If unhulled seed is used, much more seed is necessary—25 to 30 pounds being average.

Growing. It is necessary that the soil be supplied with plenty of calcium. Sweet clover is more exacting in its lime requirements than alfalfa. Almost any soil will support growth, but the plant prefers fertile sandy or clay loams. It is necessary that the seed be inoculated the same as alfalfa.

Rotation. Most varieties of sweet clover are biennial in nature. They fit into a crop rotation to good advantage. Sweet clover is usually seeded with a small grain and is followed by corn or other heavy-feeding cultivated crops.

Harvesting. As a hay crop it is harvested much the same as alfalfa. The seed crop is cut with a binder when about 75 per cent of the pods are brown. It is shocked and threshed as a grain crop.

Uses. Most sweet clover is used for pasture. The biennial types may be grazed lightly the fall of the first year and require heavy pasturing to prevent woody growth the second year. There is usually more danger of undergrazing than of overgrazing. Care must be taken to prevent bloat by exercising the same precautions as listed for alfalfa. While it is not so prevalent as with other clovers, bloat may occur when cattle and sheep are pastured. The crop may be made into hay, but usually it is not as satisfactory for this purpose. It is difficult to cure properly and some feeding problems may arise. As a seed crop, it may produce 5 to 6 bushels per acre under favorable conditions. Sweet clover makes a good green manure crop. When grown for this purpose, it should be plowed under after growth starts in the spring of the second year. When plowed in the fall, volunteer growth may result the following spring.

Honey producers find the sweet clover plant to be well suited to their needs. It provides an abundance of nectar and the resulting honey is of high quality.

MEDIUM RED CLOVER

Medium red clover is one of the most widely-grown clovers of eastern United States. The crop may be grown alone or, more commonly, in combination with other legumes and grasses.

Adaptation. It is safe to state that red clover can be grown wherever timothy is adapted. Most of the northeastern quarter of the United States is a red-clover section. In the Corn Belt it is a standard crop grown alone or in combination with timothy. It is not so exacting in its lime requirements as sweet clover or alfalfa, but does best when calcium is available. A fertile, loam soil gives the best yields.

Varieties. Most red clover is the medium red type, a typical biennial, occasionally persisting for a third year. Mammoth red clover, a coarser type, is not so widely grown as medium red.

Seeding. The crop is seeded with small grain, usually in the spring. Where the winters are mild it may be seeded in the fall. From 8 to 10 pounds of seed are sufficient under most conditions. If it is mixed with timothy, the amount of seed is reduced accordingly. In dry years it may be desirable to cut the companion crop early to favor the establishment of the clover.

Rotation. This crop is used in much the same manner as indicated for sweet clover. It is included in the average Corn-Belt rotation, a typical example of which is corn, oats, red clover. The red clover is used for hay or pasture. The first crop is commonly cut for hay and the second is pastured. Many farmers add timothy to the clover and provide a mixture well suited to both hay production and pasture.

Harvesting. For hay red clover is cut in the bloom stage. This early cutting permits two crops under favorable conditions. As stated above, many growers use the second growth for pasture.

For seed the crop is harvested when most of the seed heads are brown to black. It is common to cut the crop with a mower equipped with a buncher attachment. After the harvested material is thoroughly dry, it may be threshed on a very dry day. With a good yield, about two bushels to the acre, seed production is likely to be profitable.

ALSIKE CLOVER

This plant was believed by early botanists to be a hybrid between red and white clovers. In appearance it is somewhat intermediate between the two.

Adaptation. In the Corn Belt alsike is treated as a biennial although it may live for three or more years under favorable circumstances. While it does best in a cool climate with plenty of moisture, it is grown successfully over a wider range of conditions than red clover. It may succeed also where the soil is too low in lime content for red clover. Its ability to grow in low or poorly-drained soils has increased its popularity.

Growing. Alsike fits into the rotation much the same as red clover. In the seed-producing areas it may be grown as long as it yields successfully. The length of time the crop is grown is governed as a rule by the rate of increase of competing weedy plants.

Seeding. As the seeds are very small, 2 to 6 pounds are sufficient for an acre. The small size of the seeds makes it necessary that a firm seed bed be provided. Alsike is usually seeded with a grain crop in the spring much the same as red clover. It is often grown in mixture with timothy to produce a fine type of hay and pasture.

Harvesting. For hay, under average conditions, alsike produces but one cutting per year. In cool, moist areas, where it is especially adapted, two crops are not unusual. The seed crop is harvested when the majority of the heads are dark. It is handled much the same as red clover. Care should be exercised to avoid unnecessary handling as the seed shatters readily. Yields of 2 to 4 bushels of seed are not uncommon.

WHITE CLOVER

This plant receives its name from the color of its flowers. It is widely known because of its suitability as a lawn mixture in humid areas.

Adaptation. Like the other clovers, this crop prefers a cool, moist climate. Its ability to withstand heat, provided it has moisture, makes it capable of growing rather far south. White clover has a shallow root system and suffers rather quickly from drouth.

Seeding. The seeds of white clover are small, being about the same size as those of alsike. From 2 to 5 pounds are sufficient for an acre. The large variety, Ladino, as grown in the Pacific Northwest, is seeded at a heavier rate of 5 to 6 pounds. This variety may be used for hay production. For hay the crop is cut when in full bloom. Seed production is profitable where good yields can be secured. Since it is an important part of many lawn grass and pasture mixtures, the seed prices are usually favorable. From 2 to 5 bushels per acre are not uncommon in sections where the crop is adapted.

Rotation. White clover is rarely grown in a regular rotation, as it is used almost entirely for pasture. The low growth of the plant does not make it suitable for hay production.

LESPEDEZA

The lespedezas have become of increased importance during recent years. The manner in which they fit into the cropping systems of the South merits their receiving full discussion.

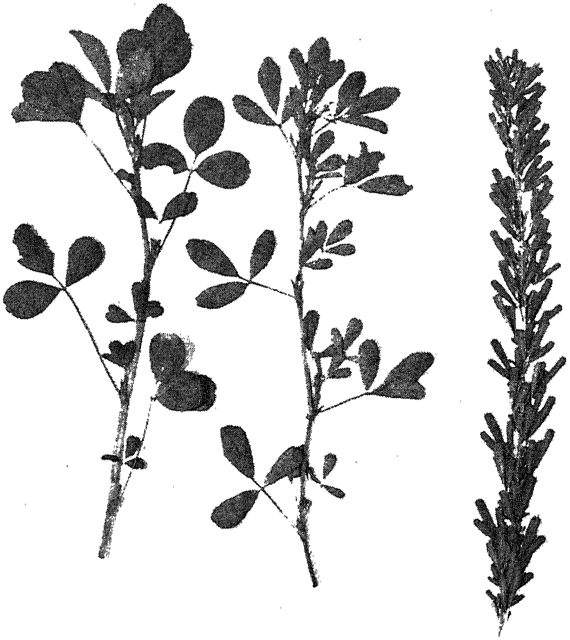


Figure 45. Alfalfa on left; lespedeza sericea on right.

Adaptation. Since it was first introduced into America, lespedeza has spread rapidly until varieties are grown from New Jersey westward to northern Missouri and Kansas and the regions to the south. The ability of the plants to grow in soils low in lime content makes lespedeza especially valuable in those areas where acidity is too high to prevent profitable growing of alfalfa. The crop prefers hot weather and does not succeed far north, as the growing season must be long for its economical production.

Varieties. The lespedezas are grouped as annuals or perennials. The annual species *(Lespedeza striata* and *L. stipulacea)* and the perennial species *(L. sericea)* are used as forage crops.

Of the annual species the principal varieties are Kobe, Tennessee No. 76, and Korean. Korean is of the species *stipulacea.* It is recognized by the long stipules of the flowers and the gray color of the seed pods as contrasted with the reddish-brown seed pods of the other annuals. The perennial species is of interest because of its persistence. The annuals usually reseed themselves and continue as long as weeds are controlled.

Seeding. In the warm sections it is common to seed lespedeza early in the spring on winter grain. The use of a hand seeder to scatter the seeds on the surface, so that freezing and thawing of the soil may cover them, is common. Most varieties are seeded at the rate of 25 to 30 pounds per acre. The larger-seeded Kobe variety should be planted at a rate of about 50 pounds per acre.

Harvesting. As a seed crop, lespedeza may be profitable where adapted. Harvest is started when the seeds are hard, using a specially equipped seed pan attached to the cutter bar of the mower, so as to save as much of the shattered seed as possible.

Uses. The crop may be used for either hay or pasture or both. It is cut for hay when plants are in full bloom. Treatment is similar to that given other hay crops. The lespedezas are at some disadvantage for feed, as they are rather high in percentage of tannin, which gives the hay a rather unpalatable taste.

THE SOYBEAN

Probably no other introduced crop has spread more rapidly in a short period of time than the soybean *(Glycine hispida).* Brought to this country a little more than one hundred years ago, it has spread until it is now grown in most humid crop-producing sections of the United States.

Adaptation. The crop is adapted to about the same conditions as corn. It does especially well in the northern half of the Cotton Belt and generally throughout the Corn Belt. Once established, it is able to grow under fairly dry conditions. While the soybean prefers fertile loam soils, it succeeds on a wide range of types, if properly inoculated. Its ability to grow on soils too acid for alfalfa or clovers has led to its extensive use as a substitute for these hay crops. The soybean is valuable as a catch crop when new seedings of grass and clover have failed. Its use as a cover crop in orchards is popular in many areas.

Varieties. The large number of varieties makes it impossible to list all within this book. A fairly complete list of the principal varieties was given in Table XX, *Agriculture I.* New and improved varieties are being developed continually as plant breeders work to overcome disadvantages of those now in existence. It must be remembered that soybeans may be grown farther north for hay than for seed. Many fairly late varieties make good hay in northern states where it is impossible to mature seed.

Seeding. It is essential that the seed be inoculated before planting. The soybean may be grown in cultivated rows or in solid drills. If the crop is grown for seed production, the use of rows is preferred to keep weeds under control. Rows 24 to 36 inches apart are best on most fertile soils; on lighter soils the use of wider spacing, as 36 to 42 inches, is preferable. If the crop is grown for hay, the use of a grain drill to provide close spacing is most common. Sometimes the beans are broadcast, but this method is likely to prove wasteful of seed and result in poorer stands.

The plan of mixing soybeans and corn is not advisable according to several experiments. Some growers prefer to grow soybeans in mixtures with cowpeas or Sudan grass. The mixtures usually yield more and provide a valuable crop. In the soybean-cowpea mixture the soybeans are seeded somewhat heavier than the cowpeas. With Sudan grass the use of about 60 pounds of soybeans and 10 pounds of Sudan drilled is an average combination.

The quantity of seed required varies with the size of the seed and the use of the crop. The smaller-seeded varieties require less seed. Planting in wide-spaced rows requires less seed than the use of close planting. With cultivated rows the amount of seed required varies from 10 to 80 pounds per acre. If close drilling is followed, about twice as much seed is needed.

Care must be taken to avoid too deep planting. This precaution is especially important on heavy soils where a crust is likely to form.

Cultivation. If a crust is formed before emergence, it is best to break it by cultivating lightly with a harrow or weeder. It is necessary to keep weeds under control. After the plants are well started, the broad leaves will tend to hold many of the weeds in check. In fact, following a period of fallow, the soybean is a good competitive crop to control weeds. If the beans are grown in close drills, the harrow or rotary hoe may be used until the plants are 8 to 10 inches high. The soybeans in wider-spaced rows may be cultivated with the common corn cultivator.

Rotation. The soybean lends itself to almost any type of crop rotation, as it may be grown either as a grain crop or a hay crop. The place will naturally depend upon the soil and the use to be made of the crop. It is very well suited to short rotations with corn, cotton, and small grains. If small grains follow the soybean, but little work is required to prepare the soil for seeding. A common rotation is corn, soybeans, wheat, and clover.

Harvesting. The method of harvest varies with the use of the crop. If the crop is grown for hay, it is usually cut when the pods are formed and before the leaves fall. As the leaves are the most valuable part of the plant, it is important that they be saved. The general method of harvesting is the same as for other hay crops. The use of a mower and curing in windrows are most practical in most sections.

Where a seed crop is grown, the plants are left until mature. If a combine is used, it is necessary that the plants be fully ripened, although there may be some losses from shattering. Many growers harvest the beans with a binder. The bundles are shocked to dry and are threshed with a machine whose concaves are removed and the cylinder operated at a reduced speed to prevent cracking of the beans.

THE COWPEA

The cowpea *(Vigna sinensis)* is somewhat like the soybean. It is a bean and not a pea, as its name would indicate. The soybean has replaced the cowpea in many parts of the South.

Adaptation. The cowpea is a crop typical of the Cotton Belt and the southern Corn Belt. It prefers a long growing season with plenty of warm weather. It will grow on almost any type of soil capable of growing crops. Like the soybean, the cowpea will succeed in acid soils. Since it is a legume, this point is important in the areas where it is grown. It is so susceptible to low temperatures that it is injured by the lightest frost.

Varieties. Many varieties are available. Many of these are listed in Chapter XII, *Agriculture I.* The more important varieties are Brabham, Clay, New Era, Whippoorwill, Iron, Blackeye, and Early Buff. The student of agriculture should check with his state agricultural experiment station to determine the best varieties for his section. Rapid improvement is being made by plant breeders in providing superior varieties.

Growing. Much of that which has been said about the growing of soybeans will apply to the cowpea. When grown for hay, the grain drill may be used, seeding from 60 to 90 pounds per acre. If the crop is in spaced rows, less seed is required. The twining growth of the cowpea makes it difficult to grow in wide-spaced rows after it attains fair size.

The cowpea crop is valuable as a cover crop and for green manure. Plowing under the plants aids materially in rebuilding soils depleted of fertility. The principal problem involved is that the seed cost may make this an expensive program.

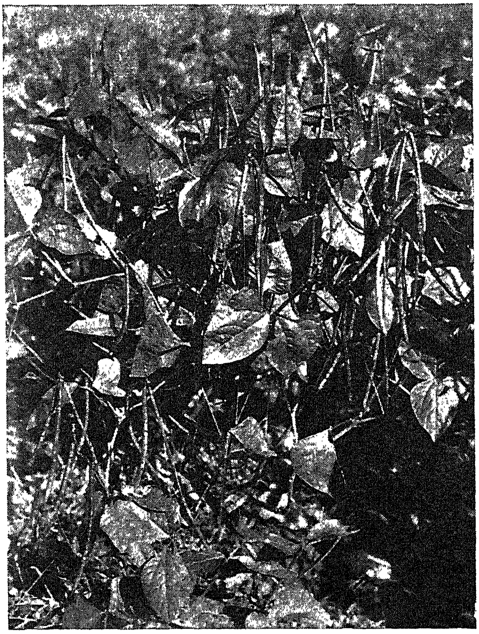


Figure 46. A well-developed cowpea plant.

Rotation. The cowpea is grown in the rotation much the same as the soybean. It frequently follows the cotton crop. It leaves the soil in good condition so that a fall-sown grain crop may be seeded with but little further preparation.

Harvesting. Hay should be cut prior to frost. As the plants continue to grow until frost, it is necessary to cut them while in the growing condition. After the first pods are formed and before the lower leaves fall is a desirable time to harvest the crop. The usual method of treatment is followed in curing the hay, much as has been outlined earlier in this chapter.

CRIMSON CLOVER

Crimson clover *(Trifolium incarnatum)* is an annual hay and pasture plant. It receives its name from the bright, crimson red flowers borne on a spike-like head which is characteristically different from the common clovers.

Adaptation. This crop is usually grown as a winter annual. For this reason it is suited to regions of mild winters. Farther north than New Jersey on the Atlantic seacoast the crop usually winterkills. Also, crimson clover requires plenty of moisture for its best development. It will grow on almost any well-drained soil whether acid or alkaline.

Seeding. It is common practice to seed in the fall. The large seeds require seeding rates of 12 to 20 pounds per acre. Some growers use unhulled seed. In this case rates should be increased about 25 per cent.

Harvesting. For hay the crop should be cut before maturity, as the plant develops fine hairs on the flower head. When these have hardened at maturity, they are likely to be injurious, especially when the hay is fed to horses. Harvesting when in full bloom, or shortly after, is a good practice.

Rotation. Many farmers seed crimson clover in their cornfields at the time of the last cultivation. In some cases, where the agriculture is intensive, the hay crop is removed early enough to permit plowing and planting to corn again. Others grow the clover in small grains, removing the two crops together for hay. Its rapid growth brings it to maturity early in the second season and makes it possible to grow another crop where crimson clover is adapted.

Uses. The early spring growth of crimson clover furnishes desirable pasture. It may also be used to advantage as a cover crop in orchards.

FORAGE SORGHUMS

We have previously considered the grain sorghums and noted that some varieties of sorghums were grown primarily for forage. Most of these are in the group known as sorgos. Sudan grass and Johnson grass may be classed with forage sorghums. As the latter crops are grown primarily for hay and pasture, they will be considered first.

SUDAN GRASS

Sudan grass *(Sorghum vulgare sudanensis)* is one of the most important of the emergency hay and pasture crops. Since its introduction from Africa in 1909 the crop has become very popular throughout a large part of the country.

Adaptation. Sudan grass, a tall growing annual, is adapted to much the same conditions as the sorghums, but it can be grown to advantage farther north than the sorghums. The plant will grow under both humid and dry conditions. Because of its ability to withstand drouth, it is favored in dry areas and in years of deficient moisture in more humid sections.

Seeding. It is desirable to delay seeding until the ground is warm, as the seedlings are very susceptible to low temperatures. Early seedings usually suffer greatly from weed competition.

The seed is planted with a grain drill or it is broadcast. With a grain drill 20 to 30 pounds per acre is about average. Broadcasting requires more seed. As the germination may be low, this should be checked before seeding. Some growers seed Sudan grass in rows and cultivate the crop. From 2 to 4 pounds of seed per acre are required where the rows are 36 to 44 inches apart. With plenty of moisture, the drilled method will produce a finer type of hay.

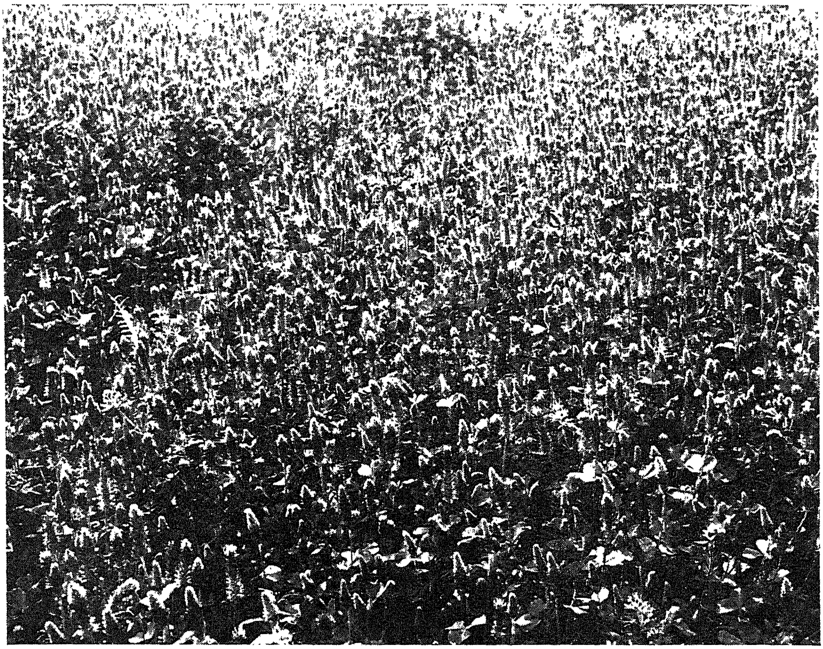


Figure 47. A field of crimson clover. Note spike-like heads.

Rotation. Much of the Sudan grass is not grown in a planned rotation, as it is used as a catch or emergency hay or pasture crop. The ability of the plant to produce heavy growth, even with late seeding, makes it very well suited for this purpose. When it is used as a regular crop, it takes the place of the hay crop in the rotation. A typical rotation would be corn or cotton, Sudan grass, spring grain, and clover. When Sudan is used as a weed-control crop, the land is cultivated until about July 1 to 15 and then seeded solid with a grain drill.

Harvesting. The Sudan grass crop is harvested for hay when the plants are heading. In many sections early harvesting permits two crops in one season. For pasturing, grazing may start when the plants are four to five inches tall. For seed, harvest when the seeds are in the hard-dough stage.

Pasturing. Because of danger from prussic acid poisoning Sudan grass should not be pastured after frost or where the plants are severely stunted by drouth. Frosted Sudan may be made into hay and fed without danger.

JOHNSON GRASS

Johnson grass *(Sorghum halepense)* is regarded as a weed in many parts of the South. Because of its perennial habit of growth it is difficult to eradicate. Where it is established, it may be used for hay and pasture much the same as Sudan grass.

RANK-GROWING FORAGE SORGHUMS

It seems desirable to consider this group separately, as the characteristics of the plants are widely different from those of Sudan grass. These plants are grown primarily for feed as fodder or stover and silage. In general characteristics, they are much like the grain sorghums, except that they have sweeter and more abundant juice in their stalks.

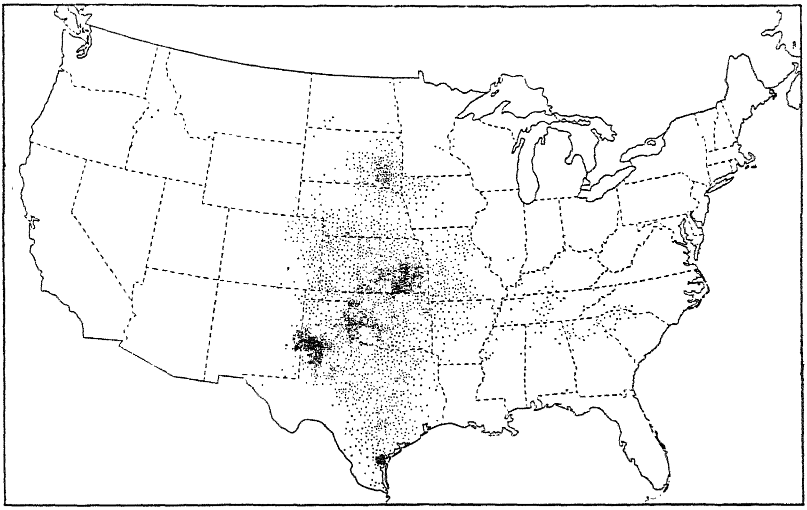


Figure 48. Distribution of sorghum harvested for forage in 1934. Each dot represents 2,000 acres.

Adaptation. The forage sorghums are grown somewhat more extensively than the grain types and are adapted to much the same conditions as the grain sorghums. On the whole, they are best suited to the southern half of the United States. The forage types can be grown farther north than the grain varieties, since it is not necessary to mature the crop for forage.

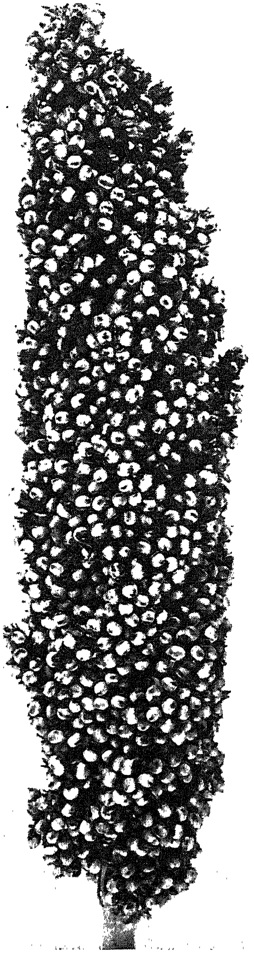


Figure 49. A head of Atlas sorgo.

Seeding. Most of these are planted in rows using an ordinary corn cultivator or a lister planter. Using special sorghum plates makes the corn planter well suited to planting sorghums. Blank plates may be purchased and holes drilled from about three sixteenths to one fourth of an inch in diameter according to the size of seed to be planted.

When a lister is used, special plates are necessary, as for corn. The lister is adapted to dry sections. It permits the placing of the seeds in furrows where moisture conditions are more favorable. As the crop is cultivated, the furrows are filled until the surface is level when the crop is laid by.

The rates of seeding vary widely with the size of the seed. If the plants are two to four inches apart in the row three to four pounds of seed are required for each acre. If the crop is planted in close-drilled rows, 30 to 50 pounds of seed are required. In humid sections this rate may be increased to as much as 75 pounds per acre. It is necessary to plant the large sorghums thick to produce a fine stalked crop more suitable for hay.

Cultivation. Thorough cultivation is essential to keep weeds under control. The harrow may be used for early tillage. Later, the shovel cultivator or the lister cultivator is used, depending upon the method of planting.

Rotation. Rotations are much the same as those given earlier in the discussion of grain sorghums. Forage sorghums are usually grown as cultivated crops. The sorghum may follow fallow, corn, or cotton, depending upon the section.

Varieties. Many varieties are available. The best varieties for each part of the United States by regions as illustrated in the map* of the United States are:

Region 1.—Gooseneck and Honey sorgos: Japanese sugarcane and Napier grass are more productive than sorghums for forage. Shallu is the leading grain sorghum.

Region 2.—Sumac, Orange, Honey, Gooseneck, White African, Sugar Drip, Rex, Colman, and Sapling sorgos. The grain sorghums hegari, Schrock, Ajax, darso, Blackhull kafir, and Grohoma are suitable dual-purpose types.

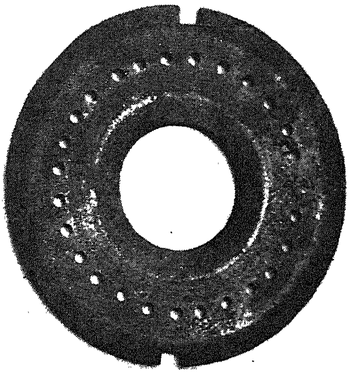


Figure 50. Plate used for planting sorghum.

Region 3.—Sumac, Atlas, Kansas Orange, and Sourless (African millet) sorgos. Hegari, Blackhull kafir, darso, several strains of Dwarf Blackhull feterita are grown for forage and grain.

Region 4.—West of the ninety eighth meridian: Sorgos: Early Sumac, Leoti and Sourless; grain sorghums for forage: Pink kafir, Dwarf (Western) Blackhull kafir, Dawn kafir, Sunrise kafir, and Freed. East of the ninety eighth meridian: Sorgos: Atlas, Kansas Orange, Waconia Orange; grain sorghums for forage: Blackhull kafir, Pink kafir.

Region 5.—Sorgos: Black (Early and Minnesota) Amber, Early Sumac, Red Amber, Dakota Amber, Waconia Amber, Fremont, Atlas, Kansas Orange; grain sorghums for forage: Greeley, Cheyenne, Freed, Dawn kafir, Pink kafir, Highland Improved Coes, and Early Kalo.

Region 6.—Sorgos: Black (Early and Minnesota) Amber, Dakota Amber, Red Amber, Fremont; grain sorghums for forage: Cheyenne, Freed, Greeley, Highland Improved Coes.

Region 7.—Sorgos: Honey, Atlas, Gooseneck; grain sorghum for forage: hegari.

Harvesting. Sorghums for forage are cut when fairly mature,

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*See *Agriculture II,* page 177.

as at this time (1) the tonnage is greatest, (2) they are more palatable, (3) they contain less prussic acid, (4) the fodder keeps better, and (5) the silage is less acid.

The method of harvesting most commonly used is the corn binder. This machine is operated the same as in harvesting corn. The tied bundles are placed in shocks or are hauled directly to the silo.

When the crop is harvested for seed, the seed is allowed to become hard. The crop is usually cut with a binder and placed in shocks to dry.

If planted solid and harvested for hay, the usual method is to cut with a mower. As the stalks are juicy, they require considerable time to dry. During warm weather there is danger of spoilage if the cut material is piled too deep.

Uses. Most of the forage sorghum is used for fodder. In some cases the heads are removed and the resulting stover is fed to livestock. Sorghum fodder is lower in protein than corn, but otherwise it compares favorably. The stover can be used as rough feed only since the more nutritious seeds have been removed.

It is claimed that the feeding value of an acre of sorghum is about 50 per cent higher when fed as silage than when fed as fodder. The crop should be mature before ensiling, else a sour, low-quality product may result.

Prussic-Acid Poisoning. The sorghums may poison livestock under certain conditions. This cyanide, or prussic acid, poisoning is very serious at times. Points to be considered:

1. Prussic-acid content greatest in young plants.
2. Proper curing reduces poison.
3. Silage is free from poison.
4. Hungry livestock should not be turned into a field of sorghum.
5. Apparently dangers are greater in the South than in the North.

The South Dakota Agricultural Experiment Station has a breeding program leading to the production of sorghums of lower prussic-acid content.

Diseases and Insects of Forage Sorghums. These were discussed earlier in Chapter XII, Corn and Grain Sorghums.

Suggestive Questions

1. What is your own definition of hay?
2. Name the principal hay and meadow crops of your community.
3. Why do the grasses serve well for hay?
4. Why are legume hays more valuable than grass hays?

5. What meadow crops would be best for dry hills? For low, poorly, drained fields?
6. What principles should be followed in determining the best time to harvest hay?
7. When is it advisable to stack hay?

Suggestive Activities

1. Prepare two or three plans for meadow mixtures of crops adapted to your community.
2. With blotters make a germination test of small seeds.
3. Make a purity test of grass seed samples secured from the local dealer.
4. Take a small sample of sweet clover seed and test for germination. Record percentage of hard seeds. Scarify seeds from another sample and make another germination test. Record results.
5. Examine alfalfa hay samples. Weigh a sample of hay carefully and then remove all leaves. Weigh leaves and determine percentage of leafiness.
6. Make a collection of the leaf parts and seeds of the various types of hay and forage plants found in your section.

CHAPTER XIV

MISCELLANEOUS CROPS

In a classification of crop plants it is difficult to draw sharp lines between groups, as was evident in the treatment of the hay and pasture plants. Several crop plants do not fit into the natural groupings. The potato is an important field crop in many sections and is so universally used for food that it is of interest to all. Both potatoes and sugar beets might be discussed with the root crops; but, because of their importance, they will be treated here.

PRODUCTION OF POTATOES

Some potatoes are produced in every state. The average annual production in the United States is about 400 million bushels. This quantity provides about three bushels of potatoes for every man, woman, and child in America. Except for bread, no other food is so universally eaten as the potato. It is frequently referred to as the Irish potato. It is rich in starch and furnishes an abundance of food energy.

Where Grown. The potato is grown widely. The plant, however, is best adapted to a cool growing season and most of the potatoes, therefore, are produced in the northern half of the United States and in the high altitudes of the western states. Many potatoes, however, are produced farther south. Here their successful production is dependent upon early planting to permit the development of the tubers before the hot weather of midsummer. The southern states find it profitable to produce early potatoes for sale on the northern markets. These potatoes command a good price and may prove highly profitable, if tubers of good quality are produced.

The largest yields and best tubers are produced in the cool climates of such states as Maine, New York, Michigan, Wisconsin, Minnesota, Idaho, and Colorado. The northern states find it profitable to produce seed tubers for use in the South where diseases are more prevalent.

Soil and Climatic Adaptation. The prospective grower should consider the adaptation of the crop before he undertakes extensive potato production. If he lives in a warmer section, then it is imperative that early planting be followed.

The potato thrives best on rich soils containing an abundance of organic matter, in regions of cool summer temperatures. Soils with a fine sandy texture are suitable, as they tend to produce clean tubers. The soil of the Red River Valley was formed by an old lake. Here the heavy, fertile soils are excellent for potato production. In Maine, where the highest yields of potatoes are produced, the soils are light, but liberal use is made of commercial fertilizers. The potato may be grown on a wide variety of soils, if moisture and plant food are available. They may be grown on peat soils, but the danger of early fall frosts may be great.

Varieties. Several factors must be considered in the choice of a variety. These are: (1) the adaptability of the variety to locality and soil; (2) the purpose for which potatoes are grown; (3) the demands of the market; and (4) the decision of growers in a community to avoid too many varieties. A description of a few leading varieties of potatoes follows:

Bliss Triumph is an early-maturing red variety. The tubers are pink to deep red and are round and blocky in shape. The eyes are medium deep, the sprouts are pink, and the flowers are lavender, fading to white in bright sunlight. On account of its earliness, it is suited to early market production. Drouth affects this variety more than some others. Triumph yields better than most varieties on peat or muck soils.

Early Ohio is about ten days later than Bliss Triumph. This variety has a pink to light red skin. The tubers are oval, slightly flattened with numerous moderately-shallow eyes. The sprouts are light green with a pinkish tinge. The flowers of the mature plant are white.

The Early Ohio variety is a good table potato, demanded by the trade in Illinois, Ohio, and Indiana. It is well suited to growing on heavy soils, but is successful in sandy areas as well.

Irish Cobbler is about one week later than Early Ohio. The tubers are white with a roundish, slightly flattened, blocky shape. The stem and seed ends are deep. The deep eyes of this potato are objectionable to some consumers. Sprouts are green, tinged with reddish pink. Flowers of the mature plant are light rose to purple in color.

This variety is an excellent table potato, selling well, especially in the markets of Kansas, Missouri, Illinois, and Kentucky. Yields are good in heavy soils.

Green Mountain is a medium-late variety with a creamy white, oblong, flattened tuber. The eyes are comparatively shallow, the sprouts are greenish white, and the flowers are white.

This variety is a good market potato and keeps well in storage. It is suited to heavy soils, but succeeds on lighter soils, if fertilizers are applied.

Rural New Yorker is a late variety with white nearly round to round-oval, somewhat flattened tuber. The eyes are comparatively shallow. The flowers are deep purple with white at tips of petals.

Rural New Yorker is a splendid all-around market potato. It succeeds well under a wide range of conditions, as it is somewhat drouth-resistant.

Russet Burbank is a medium-late variety with a yellowish to brown russet, long elliptical tuber. The eyes are shallow, the sprouts are greenish white with a pinkish tinge, and the flowers are white.

This variety is very fine for baking and is popular on the market.

Warba is one of the more recent varieties. It is slightly earlier than Bliss Triumph. The tubers are creamy white suffused with pink around the deep eyes. The blocky shape of the tuber is somewhat like that of the Irish Cobbler. The flowers are light pink. The earliness of this variety makes it excellent for an early market potato and for the home garden.

Chippewa is slightly earlier than Green Mountain. The tubers are white, smooth, elliptical to oblong in shape, with shallow eyes. The sprouts are white, tinged with pale rose purple. The flowers are light lilac with white tips. Chippewa is adapted to a wide range of conditions. It is resistant to mild mosaic disease.

Katahdin is as late as Rural New Yorker. The white tubers are smooth and elliptical to roundish in shape. The eyes are shallow, the sprouts are greenish white, and the flowers are light lilac. This variety is an excellent table and market potato. It is resistant to mild mosaic.

Planting. The potato crop should be planted on a well-prepared seed bed. On heavy soils, where erosion is not a problem, fall plowing is best. Much the same preparation is followed as with corn. The land is disked and harrowed to prepare a smooth, firm seed bed. On heavy soils where weeds are a problem, summer fallowing is ideal in seed-bed preparation. Soils which are peaty in nature should be rolled with a heavy roller to provide for soil compactness.

The time of planting varies with the use of the crop and the locality. The planting may be done as soon as the soil is warm. If the potatoes are to be produced for early market, the earlier the planting, the better.

Two general methods of planting are used, in hills and in drills. The drill method is the more common. The rows are usually 36 to 42 inches apart. Seed pieces are dropped 12 to 16 inches apart for early varieties and from 15 to 20 inches apart for the late types. On small areas hand planting is usual, but on larger farms potato planters which drop the seed pieces in the row are common. The one-man planter automatically drops the tuber pieces. With the two-man planter one man deposits the pieces in the slots of a revolving disk, thus insuring perfect planting.

The hill system of planting requires hand operation, as the rows are spaced regularly each way. This method permits cross-cultivation and better weed control.

Potatoes are planted deep enough to insure the development of the tubers sufficiently far below the surface to prevent sunburning. The depth will vary according to the soil type, with increased depth on the lighter soils. In the average clay type of soil a depth of three to four inches is usually satisfactory.

Seed potatoes should be cut into blocky, uniform pieces. The use of a liberal-sized piece provides ample reserve food for the developing plant and usually results in more rapid and thrifty growth. The seed pieces must contain at least one eye. They should be planted as soon as possible after cutting. Cut potatoes held for several days may be injured by heating or rot infection may start. Any potatoes which appear discolored upon cutting should be discarded.

Potatoes are usually cut by hand with a free or fixed knife. Automatic seed cutters may be used to advantage, if the operator is careful when cutting varieties with few eyes, such as the Cobbler and the Rural New Yorker. The quantity of seed required per acre varies with the distance between rows and the size of the seed piece. With rows 36 inches apart and plants 16 inches apart in the row, using 1.5-ounce seed pieces, about 17 bushels of potatoes are required to plant one acre.

Growing. The cultivation of potatoes is not different than that of most other crops. The object is weed control and any method which contributes to this end is suitable. In heavy clay soils proper cultivation prevents cracking of the soil and increased loss of water.

The first cultivation should be rather deep, so as to provide a loose area for tuber production. While the plants are small a harrow will do a good job in eradicating weeds with a minimum amount of labor. As the potato roots are near the surface, later cultivations must not be too deep. As soon as the plant foliage covers half the row do not plow deeper than two or three inches. A sweep type of shovel may be used to advantage. The number of cultivations will vary. Enough tillage should be given to destroy weeds and to prevent packing or cracking of the soil.

Excessive soil ridging is to be avoided in most cases, as it tends to increase the loss of moisture. On poorly-drained, heavy soils ridging may be of value in a wet season.

Care should be taken to prevent exposure of the tubers and subsequent sunburning. The cultivator may be used to throw dirt over the exposed tubers and prevent further damage.

Rotation. The potato fits into a wide variety of crop-rotation plans. As it requires considerable potassium, phosphorus, and some nitrogen, the rotation layout should provide for the availability of these elements. The plowing under of a legume crop, such as clover or alfalfa, usually provides the potato crop with excellent growing conditions.

In sandy regions where rye is an important crop the potato is excellent in preparing the land for rye, as it provides an excellent seed bed. With this plan, the rye is seeded in the fall following the harvest of the potatoes. A few typical rotations are:

1. Potatoes, rye, clover.
2. Potatoes, rye, alfalfa. Alfalfa is left down for several years. Land is then planted to potatoes.
3. Potatoes, rye, vetch.
4. Potatoes, oats, clover, corn, small grain, clover.

Harvesting. Harvesting methods vary from the use of a fork on the small farm potato patch to the large mechanical diggers which lift the tubers, separate them from the soil, and deposit them on the ground where they are gathered by the potato pickers.

Potatoes grown for the early market may be harvested before the crop has reached its full development. Potatoes, however, should be ripe, as indicated when the vines are dead. The prices paid for the earliest potatoes usually justify early harvest. Regardless of whether the grower is producing for market or for his own use, he may avoid considerable loss by exercising a little care in harvesting.

The mechanical digger should be operated as carefully as possible. It may be set to permit a cushion of earth to go over the tubers. This cushion will aid in reducing the number of cut and bruised potatoes. When the soil is dry, considerable damage will result unless the digger is operated at a reduced speed.

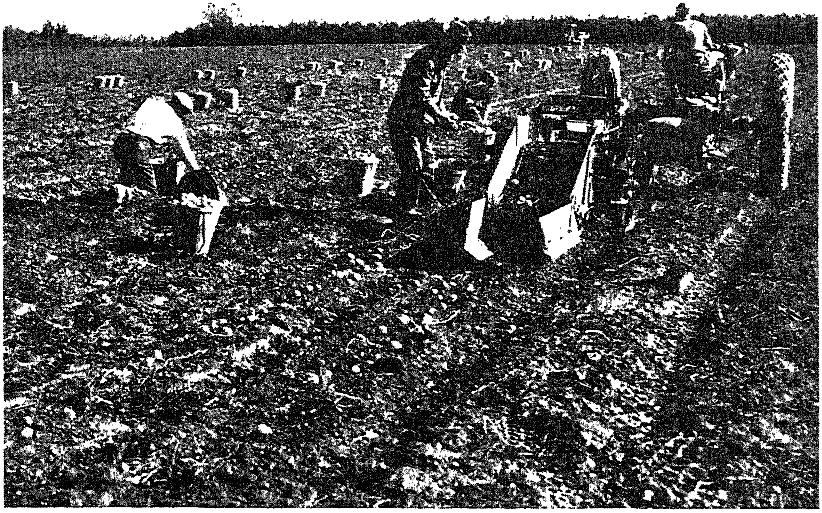


Figure 51. A potato digger in action with pickers gathering the potatoes as they are dug.

The pickers may cause much damage to tubers. It is best to permit the tubers to lie for one or two hours before picking them up. The pickers' baskets should be lined with gunny bags or other cloth to prevent bruising. Tubers must not be thrown into the baskets. The filled basket must be emptied carefully to avoid injury to the brittle tubers.

Storage. The large producer of potatoes must provide for proper storage of the harvested crop. Where many bushels are stored, a special root cellar or house is used. For proper storage one must provide control of temperature, aeration, and humidity. It is essential that only sound tubers be stored. The temperature should be kept between 35°F. and 40°F. during storage. A relatively moist cellar reduces shrinkage. A relative humidity of 85 per cent is best. Ventilation to carry away excess moisture is necessary in all storage places.

Marketing. If the price is favorable at harvest time, it is well to sell at that time. It frequently pays to store the crop for later sale. As potatoes are sold by grade, it is essential that the grower produce only the best quality of product and that he carefully grade the tubers before placing them on the market. He must also consider what variety will best meet the market demand in his field of operation.

Many growers have established certain brand names. A brand name is valuable, if the potatoes are of high quality, as it leads to the development of increased consumer demand.

The United States No. 1 grade specifications require that potatoes be free from such defects as bruises, digger cuts, second growth, growth cracks, tuber rots, scab, sunburn, sunscald, freezing injury, sprouting, insect damage, misshaped tubers, excess dirt, and discolorations either externally or internally indicating poor quality. The grower who refuses to cull out these defects is certain to receive a low price for his crop.

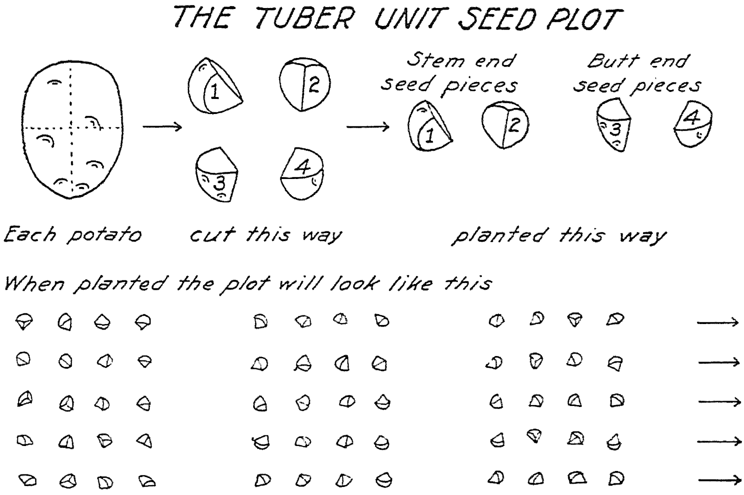
Uses. Practically all potatoes are used for human consumption. Sometimes cull tubers or surpluses are fed to livestock.

Diseases. Many diseases attack the potato. These are transmitted through the seed piece and the conditions tend to become worse as time passes. To produce certified seed it is necessary that these diseases be recognized and eliminated from the seed stock by means of an isolated tuber unit or hill-unit seed plot. Before time to plant the grower selects a quantity of six to eight-ounce tubers. Making one lengthwise and one crosswise cut, the tuber is divided into four seed pieces. Each seed piece is planted as shown in Figure 52. Diseases will be noted early in the season, as they will appear on all four plants from the infected tuber. The plot is inspected at regular intervals to detect symptoms of disease. During the season the best hills are marked and are harvested separately for next year's seed crop. All the tubers from a plant are placed in large paper bags. Each bag constitutes a hill unit for planting the next season.

After the best hills have been sacked, the grower may select individual tubers for a tuber-unit seed plot. The other potatoes are saved as seed for the commercial crop. It is important that the tuber or hill-unit plot be grown each year as a means of controlling virus diseases.

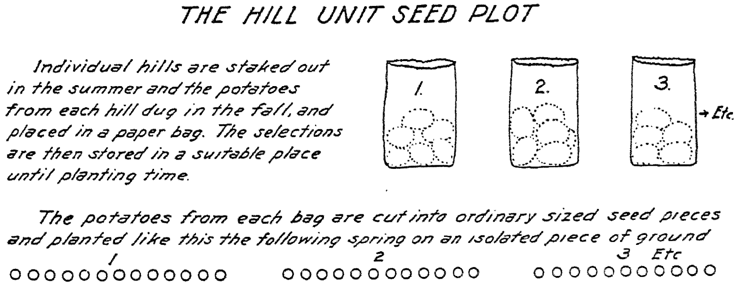
Diseases of potatoes are so numerous that it is impossible to treat them all here. The more important diseases and methods of control will be discussed.

Early blight is a fungous disease which produces dark-brown spots on the leaf surface. These spots may destroy the entire leaf.



When planted the plot will look like this

Figure 52. The tuber-unit seed plot.



Individual hills are staked out in the summer and the potatoes from each hill dug in the fall, and placed in a paper bag. The selections are then stored in a suitable place until planting time.

The potatoes from each bag are cut into ordinary sized seed pieces and planted like this the following spring on an isolated piece of ground

Figure 53. The hill-unit seed plot.

The disease rarely produces a dry rot in the tuber. It is controlled by spraying with Bordeaux mixture or copper lime dust as soon as the first symptoms appear.

Late blight, also a fungous disease, produces purple-colored, water-soaked spots on leaves in wet weather, with white mold on the lower surface. The disease develops in cool, humid weather during the late summer. A severe attack may destroy an entire field in 48 hours. This disease causes decay of the tuber both in the field and in storage.

Late blight may be controlled the same as early blight. Spraying should be started about the latter part of July. If the disease has hit the field, do not harvest for at least 10 days. As far as possible cull out all diseased tubers, as these may cause destruction of the sound tubers after being placed in storage and may result in great loss.

Rhizoctonia produces a dry stem rot on the vines and a black scurf on the tubers. It is sometimes referred to as "the dirt that won't wash off." This disease frequently destroys young plants. The fungous disease is difficult to control, as it lives over in the soil and attacks many other plants. Seed should be treated with acid mercury dip solution and all tubers with scurf spots should be discarded. A five to seven-year rotation is of value.

Blackleg is a bacterial disease which overwinters in the soil. It causes a soft stem rot and destroys the roots. The disease is prevalent during wet seasons, especially on heavy soils.

The best control lies in the use of certified seed and in seed treatment. Plant seed as soon as possible after cutting, as cut seed, standing uncovered, may be infected by the seed corn maggot which carries the disease.

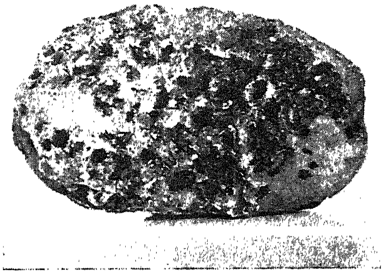


Figure 54. A tuber damaged by scab.

Potato scab is caused by a bacterial disease. The organisms cause rough, corky spots on the surface of the tuber. Insects frequently make the damage greater by piercing the tuber and affording an entrance for the bacteria. The disease is most prevalent when the soil is hot and dry. It is present in many soils, especially in those that are alkaline.

It is difficult to control scab. Tubers should be treated with the acid mercury dip and planted on land that has not produced a scabby crop. A long-time rotation may aid.

Virus Diseases. A large number of virus diseases are known to be destructive to potatoes. These diseases are carried by the tuber. Accordingly, the use of a seed plot and the growing of certified seed is imperative, if control is to be effected. The use of the hill-unit and tuber-unit methods as outlined previously should be of great value in control of these diseases.

The tuber-unit or hill-unit plot should be at least 20 rods from other potatoes. This distance helps to prevent contamination by insects.

Seed treatment to control scab, Rhizoctonia, and blackleg is desirable. While several treatments are available, two of the most common methods will be given:

1. Hot Formaldehyde. One pint of formaldehyde is added to 15 gallons of water at a temperature of 125°F. The tubers are soaked in this solution for three minutes, drained, and covered with bags or blankets for 24 hours. They should be planted immediately. Care must be taken to prevent the temperature from going below 125° or above 131°F.

2. Acid Mercury Dip. With this method six ounces of corrosive sublimate are dissolved in one quart of hydrochloric acid (muriatic acid). The hydrochloric acid-corrosive sublimate mixture is poured into 25 gallons of water. A nonmetallic container, as a stone jar or wooden barrel, must be used. The potatoes remain in the solution for five minutes. If cut potatoes are treated, they should be planted immediately. About 25 gallons of the solution are sufficient to treat 40 bushels of tubers. Corrosive sublimate is a deadly poison and extreme care must be exercised in its use. Keep all animals away and pour any remaining solution where it can do no harm.

Insects. Like all other economic plants, the potato is attacked by many insects and diseases. Some of the insects are the same ones that attack corn. A few of the more important insects will be discussed:

The Colorado potato beetle is known by all potato growers. The adult is a yellow-striped, hard-shelled beetle which lays clusters of yellow eggs on the undersides of potato leaves. In about a week, the eggs hatch and the young larvae appear. These are soft reddish brown slugs which devour the leaves.

Spraying with poison sprays, as lead arsenate or calcium arsenate, is effective in controlling the potato beetle. Adding two pounds of calcium arsenate to 50 gallons of water gives an effective spray mixture.

The flea beetle is a small, black oval-shaped insect. The adult feeds on the lower sides of the potato leaf, giving it the appearance of having been punctured with fine shot. These insects are harmful primarily in that they spread the spindle tuber disease; also, that the larvae burrow into the tuber and may be responsible for entrance of the scab organism into the tuber.

The flea beetle is best controlled by spraying both sides of the leaves with Bordeaux mixture applied under heavy pressure.

The blister beetle may be slender, and gray, black, or striped yellow. Many people know it as the "potato bug." The insects feed upon the foliage and are controlled by the same methods as the Colorado potato beetle is.

The leafhopper is a slender, pale-green insect which sucks juices from the potato leaf. The areas between punctures and the margins of the leaves dry out, turn brown, and roll upward. The best treatment is to spray thoroughly with Bordeaux mixture. This spray acts as a repellent.

Other insects which damage potatoes are grasshoppers, aphids, white grubs, and wireworms.

SUGAR BEETS

The sugar beet is the most important sugar-producing plant grown in the United States. Sucrose, the sugar of ordinary household use, is extracted from the tissues of the beet and is identical with that secured from sugar cane. The sugar beet stores its sugar in the root, while sugar cane stores it in the vegetative stalks. The quantity of sugar stored in the sugar beet is high, averaging 15 per cent of the total weight of the root. The content is important, as it means that, with the higher production per unit of crop, profitable production is much more likely. The practicability of raising sugar beets depends upon a high sugar yield, as the labor costs in its production are high.

Where Grown. There are three general areas of sugar-beet production in the United States. These are: (1) the humid area in the North Central states; (2) the Mountain States region; and (3) the Pacific Coast section. About 25 per cent of the beets of the United States is produced in the humid area, about 55 per cent in the Mountain States section, and about 20 per cent in the Pacific Coast region. The prospective grower living in other sections of the United States probably is not justified in growing sugar beets. The beets are grown under definite contracts with the sugar-producing companies. These contracts are essential to profitable sale of the crop.

Adaptation. The sugar beet, being a fleshy plant, requires an abundance of moisture during the growing season. As the season progresses and the plants develop there is increased need for water. For this reason, the sugar beet suffers greatly if drouth periods occur late in the summer.

In addition to ample water supplies, the beet requires a long and fairly cool growing season. Most of the beet-sugar factories are located in areas having mean summer temperatures of between 67° and 72°F., as shown in the illustration below. The beet may be grown outside these limits, but production generally has not proved profitable. Warm sunshiny days and fairly cool nights are ideal for the sugar beet. The plant continues to grow as long as temperature and moisture conditions are favorable.

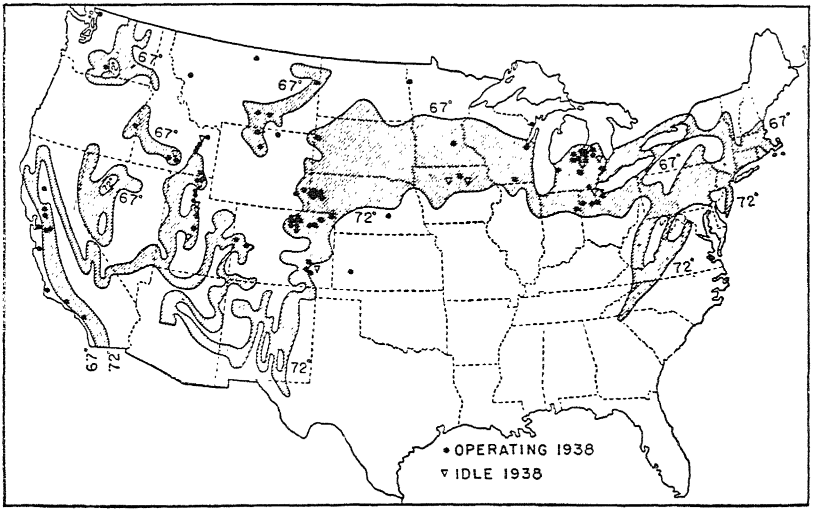


Figure 55. Location of beet sugar factories in the United States. The zone lying between the mean summer isotherm of 67° and 72° F. is shown as a shaded portion.

Thus, the longer the favorable period, the higher will be the production. As the value of the crop depends upon the quality as well as the quantity, it is important that a high percentage of sucrose be produced by the roots. The increasing coolness of the nights in the latter part of the growing season, together with warm, sunny days, tends to slow up vegetative growth and to increase the rate of sucrose storage.

Soils. The sugar beet is a heavy-feeding crop and for its best development requires a fertile soil. As the value of the crop is high, the grower can afford to give it the best place in the rotation, as, where it is grown, the sugar beet may be highly profitable. Almost any good mineral soil of the dark-colored heavier types is suited to sugar-beet production. Sandy or light soils usually produce lower yields and are not so desirable as the heavier soils. Muck soils may be used to grow sugar beets provided their mineral content is satisfactory. If the soil is unsuitable, it may produce beets of a low-sugar content.

As the sugar beet produces a deep taproot, a deep soil with good drainage is essential. Soils with hard or impenetrable subsoils are not satisfactory. The best sugar-beet soils are more or less uniform in structure to a depth of at least three feet. Without proper drainage the beet is unable to develop properly, and poorly-shaped, low-quality roots are likely to be the result.

Planting. The more thorough the seed-bed preparation, the better the control of weeds. Fall plowing is desirable where practical, as it permits a better labor distribution and hastens decomposition of organic matter. Most tests indicate the advantages of rather deep plowing, as a better seed bed is provided for the developing beet. The heavy soils to which beets are especially suited are likely to be in better condition after fall plowing. A thorough job of disking previous to plowing cuts up the litter and facilitates a better job of covering. Muck soils are likely to be rather loose and should be compacted to prepare a good seed bed.

Following plowing, the field should be tilled with a weighted disk. The spring-tooth harrow is used by some growers and does a good job of pulverizing as well as destroying numerous weeds. The spike-tooth harrow is used by many growers to prepare a mellow seed bed. It is essential that the seed bed be firm. A cultipacker is a valuable implement for this purpose. It is a good practice to work the seed bed well in advance of seeding to encourage the germination of weed seeds. The destruction of every crop of weeds means less trouble later in the season.

As weeds are a serious problem, planting is done so as to permit cultivation. Most growers use a beet drill and space the rows from 18 to 24 inches apart. Most beets are planted 20 to 22 inches apart. Many growers plant in paired rows either 14 or 16 inches apart with a wider space of 22, 24, or 26 inches between the pairs. The quantity of seed required per acre varies from 17 to 20 pounds. When a hill-drop or checkrow drill is used, less seed is required. The seeds are planted shallow, especially when the plantings are made early. The depth of planting is important, as a crust may form on the surface and prevent the seedlings from emerging.

Thinning is necessary, as the beet-seed ball contains several seeds. Much of the thinning is done by hand, with a short-handled hoe to cut out extra plants and leave clumps about 10 to 12 inches apart. This kind of thinning is called blocking. Some growers follow the practice of machine blocking. With this method the beet cultivator is driven across the field at right angles to the direction of the rows, to remove the excess plants and leave the blocks in straight rows, so that cross-cultivation is possible. Shortly after blocking it is necessary to go through the field and remove all but one plant from each block.

As the beet is a heavy-feeding crop, it pays to provide adequate supplies of plant food. They may be applied when the crop is planted, during soil preparation, or at the time of cultivation. Special attachments are fitted to the drill or cultivator and permit the proper application of fertilizer. It may be applied at the time of planting at rates of 150 to 200 pounds per acre. If the fertilizer is broadcast, heavier applications are needed. It is usual to supply needed nitrogen through the growing of legume crops.

Sugar-beet seed is produced the second year of the plant's life and it is necessary to carry the roots through two seasons to secure a crop of seed. As it is impractical for the grower to produce his own seed, a new supply must be purchased each year. The sugar-beet companies usually care for the needs of the growers with whom they have contracts.

Cultivation after thinning is done with a beet cultivator and usually considerable hand labor is necessary. It is essential that weeds be destroyed, if good yields are to be secured. Many growers give the crop at least two hoeings following thinning.

Rotation. Since the sugar beet is valuable as a cash crop, it receives the best place in the rotation. Accordingly, any legume or grass crop that is grown may be turned under in the fall or spring to provide an abundance of organic matter and available plant food. Following the hay or pasture crop, the problems with weeds are likely to be less serious. As the young beet is a poor competitor with weeds, this factor is of great importance. In some sections there is objection to the use of a leguminous crop, because, where alfalfa or sweet clover precedes beets, these crops may increase the likelihood of seedling diseases. Apparently these legume crops favor the seedling diseases. Where these are serious it may be necessary to plant corn or other cultivated crops after the legume, and these crops are followed by sugar beets. The application of commercial fertilizers may be made at the time of planting the beets to correct any deficiencies in fertility.

As the sugar beet is harvested late in the fall, it is necessary to follow it with a spring-sown crop. The usual practice is to plant a spring grain, such as oats or barley. Corn may be grown to advantage after sugar beets where the crop is adapted.

Harvesting. The sugar beet is permitted to grow as long as possible without incurring danger from freezing. Samples are usually taken from the fields early in the fall to determine the quality of the crop. When the harvest time approaches, the sugar company usually gives orders to the grower as to the time of harvest and delivery of his crop. The factory operator must plan so as to provide for a continuous supply of beets.

While mechanical harvesters and toppers have been designed, most beets are lifted from the ground with a beet lifter. The loosened beets are pulled from the soil, knocked together to remove excess soil, and piled. Next the topper, using a knife with a hook on the end, picks up each beet and cuts off the top. The cut is made through the beet at the lowest leaf scar. The topped beets are thrown into piles, loaded into trucks or wagons, and hauled to the loading station or factory. The tops may be fed to livestock or may be placed in a silo for silage.

Uses. The uses and by-products of sugar beets have been stated in *Agriculture II.*

Diseases. Several diseases cause great damage to the sugar-beet crop. Probably the most important are Cercospora leaf spot and the seedling blights.

Cercospora leaf spot is a serious disease of the sugar beet in the humid area. It produces small circular spots on the leaf blades. The spots may increase in size until the leaf turns brown and dies. A severely-attacked field looks as though it had been scorched by fire. This disease is worst during wet seasons. The most effective control has been to apply Bordeaux mixture or to dust with copper fungicides three or four times during the season, with the first application made early. A good rotation which insures at least three years between sugar-beet crops will aid in control.

The seedling diseases cause a blighting or damping-off of young seedlings. The damage is worst in poorly-drained fields. Control measures are crop rotation, growing of a cultivated crop after the legume and before sugar beets, adequate drainage, and the use of phosphatic fertilizers. Dusting the beet seed with organic mercury dusts or copper compounds has proved beneficial in checking seedling blight.

Insects. The principal insect pests of the sugar beet are cutworms, white grubs, wireworms, flea beetles, and grasshoppers.

Cutworms injure the crop when small by cutting it off at the surface. They can be controlled by fall plowing and by the use of poisoned bran mash spread between the rows of the infested part of the field late in the evening when the worms work.

White grubs feed upon the roots. Crop rotation to avoid damage is desirable. If the land has been under clean cultivation for at least two years, there is less danger from damage.

Wireworms develop in grasslands and where the soil is poorly drained. Fall plowing and crop rotation are the best means of control.

Flea beetles are not easily controlled, as they feed upon the leaves. Applying 50 to 150 pounds of hydrated lime per acre may be of value in checking damage.

Grasshoppers attack beets the same as other crops. The use of a poison bait as outlined earlier in the discussion of corn is advisable.

Marketing. As practically all sugar beets are produced under contract with the sugar companies, marketing plans are arranged by the factories. The price to be paid is in the contract and the quality of the product is considered. As with other products, the price paid varies with the supply and demand for sugar.

Suggestive Questions

1. Why should potatoes be planted early?
2. What are the leading varieties of potatoes in your section?
3. How does the tuber-unit seed plot differ from the hill-unit seed plot?
4. Why is it true that cane and beet sugar are exactly alike?
5. What is regarded as a good yield of sugar beets?

Suggestive Activities

1. Treat a lot of potatoes for scab, using recommended methods.
2. Prepare a chart giving the important potato insects, descriptions, and methods of control.
3. Secure mature beet plants before frost, and store in sand in a cool place. Later, set out in pots and the plants will bloom.

CHAPTER XV

ROOT CROPS AND SILAGE

The root crops are those plants grown for their fleshy roots. They are usually produced for livestock feed only, but some varieties serve for human food also. Carrots and rutabagas are types used for both purposes. The sweet potato is grown principally for food. The varieties grown for livestock are usually different from those used for food. The root crops as a group are highly succulent and serve the purposes of vegetables for mankind and much the same purpose as silage for livestock.

ROOT CROPS

The production of root crops for livestock feeding is important, especially in the northern border states where the growing season is too short for the best growth of corn. The dairy farmers of this region may use root crops instead of silage, as the root crop provides a succulent feed during the winter months. Some growers believe that roots act as "conditioners," to keep the livestock in better health. A few of the more important root crops will be considered.

MANGELS

The mangel, or, as it is sometimes called, the mangel-wurzel is our most important root for livestock feeding. The habits of growth of the mangel are very much the same as those of the sugar beet to which it is closely related.

Adaptation. The mangel is best suited to areas of cool growing seasons. The best production is obtained in the northern states and Canada. Mangels will yield on a wide variety of soils, but do best on loose fertile soils which permit the greatest development of the fleshy modified stem and root.

Varieties. The mangel has not been improved to the same extent as many of our other economic crops. For the most part the same varieties have been grown for years. Varieties are classified as to shape, as globe, ovoid, tankard, half-long, and long.

Two of the better varieties are Yellow Globe and Mammoth Long Red.

Seeding. Like the sugar beet, the mangel requires a well-prepared seed bed. The young plants do not compete well with weeds, so it is essential that the seed bed be as clean as possible.

As soon as the ground is warm, the seed is planted either with a beet drill, ordinary grain drill, or a corn planter equipped with special plates. Like the sugar beet, several seeds are in each seed ball and the result is a thick stand which must be thinned. If a beet drill has been used, the rows may be cross-blocked or they may be blocked by hand. Blocking is done by removing the plants at regular intervals of 10 to 12 inches in the row. After this blocking and bunching, it is necessary to go through the field and remove the excess plants from each bunch. One healthy plant is left in each block.

Using rows 30 inches apart requires 10 to 12 pounds of seed per acre. Care should be exercised to avoid deep planting. A depth of about one inch is best in most soils.

Cultivation. Mangels are cultivated much the same as any other row crop. If the rows are close together, a sugar-beet cultivator may be used to advantage. With the wider spacings many farmers use an ordinary corn cultivator.

Rotation. As it is a cultivated crop, the mangel occupies much the same place in the rotation as corn. In the northern states, where it is grown, it is frequently used to follow clover or other legume or grass crops. In many northern sections it is of especial value in the rotation, as it provides the only opportunity to destroy weeds which tend to become serious under conditions of more or less continuous small grain and clover cropping plans.

Harvesting. The crop is harvested as soon as growth stops, as indicated by falling of the outer leaves. By all means, the roots must be harvested before cold weather, as severe injury may result from heavy frosts. The roots may be lifted with a beet puller or on a small scale by hand. The leafy tops are removed by cutting or twisting off the leaves. It is necessary that the harvested roots be stored in a ventilated place where they will be protected from freezing. Care must be exercised to avoid bruises and cuts, as these will speed decay in storage and may lead to the loss of the entire lot. Yields of mangels, under favorable conditions, may be as high as 20 to 30 tons per acre.

Uses. Most mangels are produced on small farms where they serve as feed for livestock. The majority of the crop is fed during the winter months without special preparation other than to chop the roots into pieces. The dry matter in the mangel is about the same as that in corn silage. The root is largely water, averaging about 90 per cent in most cases. A great deal of water, therefore, is being handled and fed, and the result is that the mangel is an expensive crop to grow, when one considers the costs of production. Its ability to succeed under cool conditions unsuited to the production of corn, however, gives it a place in the agriculture of the border states.

CARROTS

The carrot crop is used for livestock feed in much the same manner as the mangel. The crop is not so widely grown as the mangel, however; but the livestock varieties are larger and coarser than those used for human consumption.

Varieties. The principal feed varieties of carrots are Danvers Half-Long, Oxheart, Large White Belgian, and Maude S.

Seeding. The crop is grown much the same as the mangel. The seeds are small and but one to two pounds are required per acre. As the carrot grows very slowly, it is important that the seed bed be free from weeds, or the grower is likely to find it impossible to locate the rows of the plants. Some growers follow the practice of mixing in a small quantity of a fast-growing seed, as the radish, to serve as markers for the location of the carrot rows.

Harvesting. Carrots are harvested when the roots are mature. They are resistant to ordinary freezing and may be left in the field until after frost. The result is a firmer root less subject to injury in handling.

Storage. Carrots are stored in root cellars or in piles covered with straw and soil. Proper ventilation is essential, if rots are to be avoided.

RUTABAGAS AND TURNIPS

The rutabaga and the turnip are closely related and are very much alike in their characteristics. Like the carrot, each is used for human food. Larger, coarser-growing types are used for livestock feed.

The rutabaga and the turnip are grown in cultivated rows. Their seeds germinate rapidly. Weeds are, therefore, more easily controlled than is possible with carrots and mangels. From 1½ to 2 pounds of seed are required for each acre. Both crops are handled much the same as the other roots. Many growers prefer the turnip to the rutabaga, as it usually produces higher yields.

SWEET POTATOES

While this crop may be regarded as a vegetable, it is a field crop in certain sections of the South. It is an important truck crop along the Atlantic seaboard as far north as New Jersey. It is true that it is primarily a southern crop and it is in the South that we find the bulk of the production.

Adaptation. As indicated above, the sweet potato is a warm-weather plant. The crop is grown fairly far north, especially where sandy soils are available. The sweet potato plant prefers a warm well-drained soil. For this reason, the sandy soils are advantageous. After the crop is established it will develop with a minimum of moisture during very hot weather. Wet seasons or poorly-drained, heavy soils are unsuited to the best development of the crop.

Varieties. The general types of sweet potatoes are yellow, red, and white. The yellow and white fleshed varieties are usually of better quality than the red. Nancy Hall, Porto Rico, Jersey, Dooley, and Triumph are among the leading and most popular varieties.

Planting. The sweet potato is started from small plants known as slips. These are produced by bedding sweet potato roots in clean or sterilized soil. The small vines are broken off and transplanted to produce the commercial crop. Three to four bushels of roots may produce enough slips or cuttings to plant an acre. Tubers should be placed at least half an inch apart to prevent rots from spreading from one to the other. Bedding should be done four to six weeks before time to plant in the field. For this reason, a cold frame or hotbed should be used to start the slip production.

The soil should be plowed early and deep to permit a loose open seed bed. Many growers throw the soil into narrow ridges about three feet apart, using a special plow. The slips are planted on the ridge about 16 inches apart in the row.

Cultivation. Cultivation is practiced throughout the first part of the season. Considerable hand hoeing may be necessary to keep the weeds under control. As soon as the vines cover the surface, the cultivation is discontinued and the crop is laid by.

Harvesting. The sweet potato crop is harvested before the first frost. Special diggers are used to lift the roots from the soil. The machine is equipped with two rolling coulters to cut away both sides of the ridge. A U-shaped piece of steel between the plowshares loosens the tubers. The tubers are easily removed by pulling on the vines. Tubers are permitted to lie on the surface to dry and are then hauled to the storage place. They may be marketed at once or stored in well-ventilated cellars for marketing later in the season. Especial care must be taken to cull out all damaged potatoes, as they may spread rots. The sweet potato does not stand storage as well as the Irish potato. Added care is, therefore, essential. Many people are very fond of canned sweet potatoes. In this form there is an outlet for much of the crop.

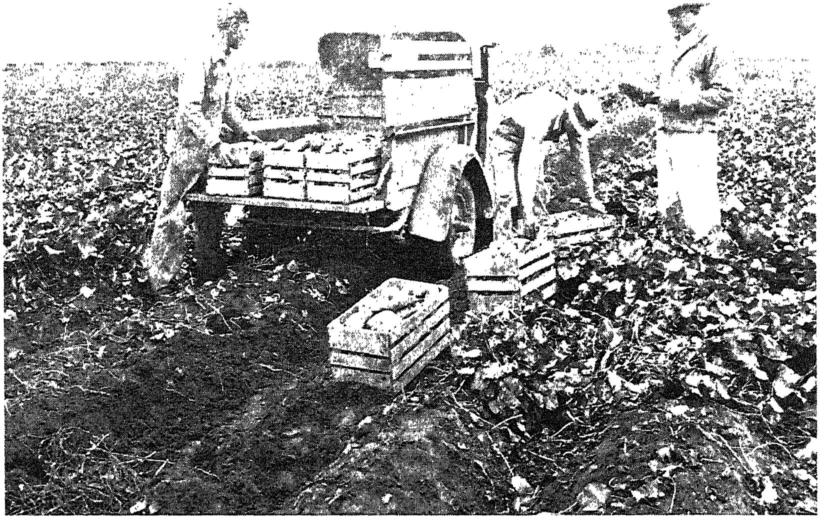


Figure 56. Harvesting sweet potatoes.

SILAGE CROPS

While we have considered corn and sorghum silage in an earlier chapter, certain phases warrant treatment here. Silage may be made from almost any green vegetable matter provided proper conditions are present. The legumes may be ensiled if provision is made to prevent their spoilage. The desirability of the silo and silage has led to many debates. Although its use has many proponents, some farmers believe that silage is an expensive type of feed unwarranted under their conditions.

Sunflowers for Silage. In sections where corn is not well adapted, as in the Northwest, many farmers have used sunflowers for silage. Here the sunflower outyields corn in the production of tons of silage both under dry-land and under irrigation conditions. In Minnesota studies, yields of 16 to 17 tons per acre were produced.

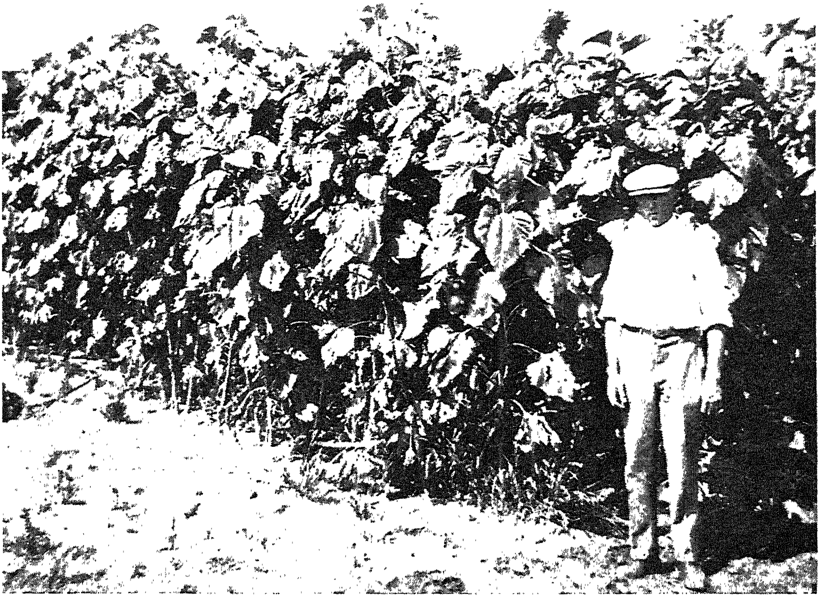


Figure 57. A crop of sunflowers grown for silage.

Seeding Sunflowers. When the ground is warm, sunflowers for silage are seeded in rows much the same as corn. The crop may be planted in drill rows or checked. The use of drills is more common. With rows 30 to 36 inches apart and plants 3 to 6 inches apart in the row, from 6 to 8 pounds of seed are required to plant an acre.

Harvesting. Sunflowers for silage may be cut early. Several investigators recommend harvest at the beginning of blossoming, finding that the quality of silage was superior when the plants were harvested at this stage. Both the grain and forage sorghums make good silage. They are not equal to corn, on an average, but approach it in quality. The sweet sorghums are somewhat superior to the grain types. In the dry sections of the country sorghum will produce a greater tonnage than corn and thus has an advantage. Sudan grass makes good silage. The plant contains sufficient sugar to insure proper fermentation when harvested at any stage of growth.

Small Grain Silage. In some areas, as in the Northwest, oats and vetch yield more tonnage than either corn or sunflowers. It has been shown that this combination makes a satisfactory silage. Rye silage is not as palatable as desirable, but is suitable for feeding, if harvested when the grain is in the late milk or early dough stage. Wheat cut in the early dough stage likewise produces satisfactory silage.

Legume Silage. The production of silage from legumes has created several problems. The principal problem is that the legumes are deficient in fermentable sugars which are changed in the silage formation process to produce acids which preserve the material against spoilage. Some workers have succeeded in producing satisfactory silage from the legumes, as alfalfa, by mixing in a high carbohydrate feed, such as corn or sorghum. In Kansas it was found that alfalfa alone made satisfactory silage, if the product could be fed within a few months after ensiling. The addition of corn meal, molasses, sorghum stover, or green rye was effective in making alfalfa silage that could be preserved satisfactorily.

As a rule, it does not pay to put legumes in the silo. They may be preserved in the form of hay at a much lower cost. Probably the only time when such storage is justifiable is during periods of prolonged wet weather, when it is impossible to cure the hay in the field.

Sugar-Beet Silage. Sugar-beet tops, removed at the time of harvest, make good silage. If these are stored while still green, it is unnecessary to run them through the silage cutter. They may be blown into the silo directly. The product will mat together and produce a silage of satisfactory quality.

Pea Silage. The use of the vines from the pea-canning industry serves as a source of silage. Most of the farmers stack the vines at the viner and permit the formation of stack silage. While there is considerable waste, stacking is probably more economical than placing the material in a silo.

Value of Silage. Investigators compute the average ton of silage to be equal to 4.6 bushels of corn and 270 pounds of hay.

Using these figures as a basis, one can compute the value of silage according to the market price of corn and hay. The Iowa Agricultural Experiment Station reported corn silage as worth $4.50 per ton and fodder $5.05 per ton on the basis of the quantity consumed in each case. The initial cost of the silo and the added labor in filling it must be considered in determining its place on a given farm.

Suggestive Questions

1. Under what conditions would you advise the growing of root crops for livestock?
2. Why is it always necessary to thin mangels?
3. How are root crops fed to livestock?
4. Why is it advisable to plant a rapid-growing crop seed with carrots?
5. Why is it difficult to produce good legume silage?

Suggestive Activities

1. Make a study of silos in your community. Learn the cost of the silo and from farmers compute the cost per ton of producing silage.
2. Secure catalogs and bulletins dealing with different types of silos. Determine which type would be best in your community.
3. If possible, observe a pit silo. Determine the cost of construction and from the losses decide whether it is economical or not.
4. Visit a farm where silage is being fed. Collect samples and note the flavor. How does it compare with sauerkraut?

CHAPTER XVI

SWEET CORN AND PEAS

The canning of fruits and vegetables has grown to be an enormous industry. In many sections the farmers derive all or part of their income from crops used for canning. Although nearly every food may be preserved in cans, we shall confine our discussion to sweet corn and peas as representatives of the industry. These two crops are among the most important in the country and merit special consideration.

The following Table gives the production of sweet corn and peas for the five most prominent states in their relative order:

TABLE XXVII—CASES OF SWEET CORN AND GREEN PEAS PACKED IN THE UNITED STATES (1937)

Sweet Corn		*Peas*	
Illinois	4,771,000	Wisconsin	7,077,000
Minnesota	3,740,000	Washington	2,271,000
Iowa	3,054,000	Maryland	1,896,000
Maryland	2,486,000	Utah	1,764,000
Indiana	2,231,000	New York	1,749,000
United States	23,541,000	United States	23,467,000

SWEET CORN

Sweet corn ranks among the three most important canned vegetable foods in America. While its production is specialized in but a few areas, the use of the processed food is almost universal.

Adaptation. Sweet corn may be grown in almost every state, but should not be grown as a canning crop except where it is especially adapted. The sweet corn plant is tender and, therefore, easily injured by frost or excessive heat. The spring months should be warm enough to permit uninterrupted growth. Hot, dry weather is unfavorable to a high-quality product. Rainfall of 30 to 40 inches is sufficient under most conditions. The crop succeeds on any fertile, well-drained soil.

The prospective grower must consider the economic adaptation of the crop. If there is no convenient market, production on a large scale can not be profitable. Nearness to a canning factory which contracts to purchase the crop is essential.

Varieties. Many standard varieties of sweet corn are available. These varieties, their characteristics, and place of greatest production are given in Table XXVIII.

In addition to the varieties listed in Table XXVIII, several of the experiment stations are carrying on sweet-corn improvement programs. Many of the large canning companies use hybrids almost entirely. In some cases these companies carry on their own breeding program. Much of the sweet corn grown in New England is hybrid. The single cross is used extensively for the production of the commercial crop.

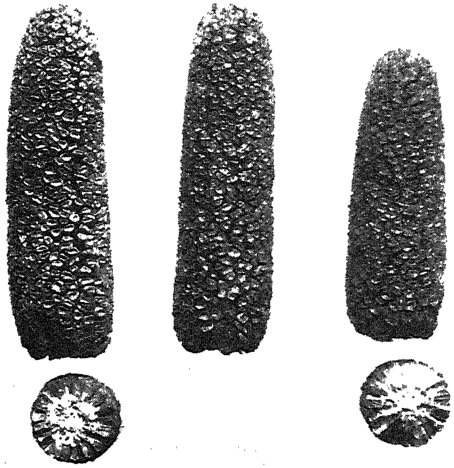


Figure 58. Country Gentleman sweet corn.

Growing. Special care should be given to prepare the soil well. Fertilizer should be added to insure productivity. Either barnyard manure or commercial fertilizer may be applied at the time of planting or, if preferred, at the time of the first cultivation. Barnyard manure adds needed plant food and improves the organic-matter content of the soil.

TABLE XXVIII—Principal Standard Sweet Corn Varieties, Characteristics, and Place of Growth

Variety	*Characteristics*	*Where Grown*
Golden Bantam	Early, 8 rows, yellow	General
Crosby	Early, 12 to 16 rows, white	Maine, Minnesota
Country Gentleman	Late, irregular, no rows, white	Central states
Stowell's Evergreen	Late, 14 to 20 rows, white	Central states
Early Evergreen	Earlier than Stowell's	North Central states
Golden Cross Bantam	Early midseason 10 to 14 rows	Central states

The sweet-corn crop is planted much the same as field corn. The sweet-corn seeds are usually smaller, and a bushel will often plant a larger acreage. This advantage may be offset by heavier planting on fertile soils.

As sweet corn does not grow as tall as field corn, it may be grown closer than field types. The short-growing early varieties may be planted 30 to 36 inches apart, while the larger later types are spaced 36 to 42 inches. If the seed is drilled, stalks may be 12 to 15 inches apart in the row. The more fertile the soil, the closer may be the spacing.

Rotation. Sweet corn is used in the rotation much the same as field corn. Where the crop is produced on a truck farm, it is common to use other canning or vegetable crops in the rotation. A typical rotation is: sweet corn, fall rye plowed under in spring of second year and the field planted to tomatoes, peas, wheat, or hay. Many farmers grow the sweet corn in a simple rotation of corn, oats, clover. As the crop is a heavy-feeding cash crop, it is important to give it as much advantage as possible.

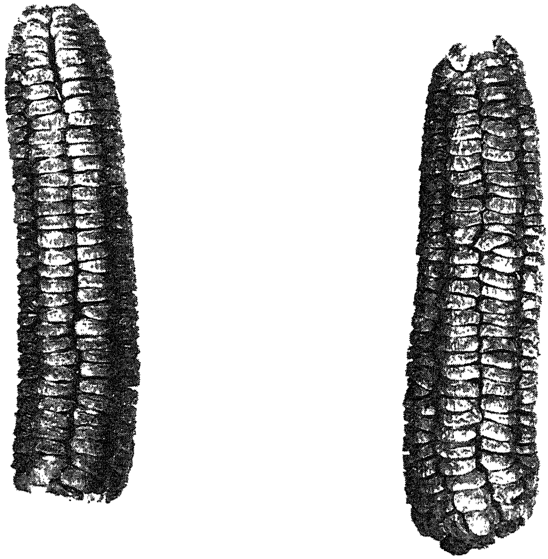


Figure 59. Golden Bantam sweet corn.

Harvesting. The new hybrid lines are especially valuable where adapted, as they generally mature more uniformly than open-pollinated types. As it is practical to make but one harvest, it is desirable to have as much of the mature corn as possible available at one time.

Corn should be harvested when the kernels are plump and full of milk. The kernels usually reach this stage at about the time the silks begin to turn dark brown. As the quality of the canned product depends upon harvesting at the proper stage, it is important that harvest be made when the crop has reached the peak of condition.

The higher the sugar content of the kernel, the better the quality of the corn. Usually, the sugar content is highest at the milk stage. Shortly afterwards the sugars change to starch and the corn is much less palatable. Also, the toughness of the seed coat increases with the age of the corn. The desirable stage is when the seed coat is tender and the corn is sweetest. Usually, the canning factory representatives visit the fields and advise the growers as to the best time to start harvest.

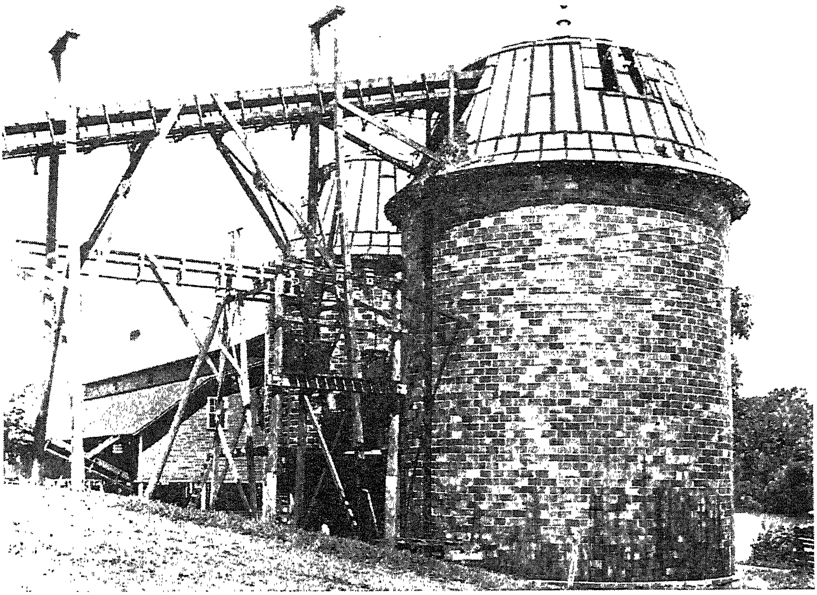


Figure 60. Silos used for preserving the husks and other waste from sweet corn.

It is usual to harvest sweet corn in the early morning, so that it may be hauled to the factory without delay. In some sections the corn is gathered late in the evening and hauled at once to the factory which operates day and night. The ears are snapped from the stalks and hauled to the factory with the husks attached. The small undersized ears are left on the stalks.

Marketing. Sweet corn ears are bought by the ton. It is not unusual for a field to yield four tons per acre. Higher and lower yields may be produced depending upon the variety and the conditions under which it is grown.

Storage. A large amount of sweet-corn waste accumulates from the husking machines. It is not uncommon to store this waste in silos where it develops into valuable feed. Some factories stack the waste in large ricks. The stacked material forms a type of silage, although wastes are large as a result of spoilage on the exterior.

Diseases. Many of the diseases of field corn cause losses in sweet corn. The root rots are especially bad. The grower in areas where these diseases occur should choose his seed supplies carefully and treat his seed with an organic mercury dust.

In some sections, particularly in the regions of high temperatures, bacterial blight, or Stewart's disease, may be a serious problem. The best control lies in the use of resistant varieties as developed by the experiment stations.

Insects of sweet corn. In general the insects of sweet corn are the same as those infesting field corn. Probably the most serious pest is the corn-ear worm, as it severely reduces the market quality of the ears.

PEAS

Peas rank first among the canned vegetables, leading tomatoes and sweet corn, the crops of next greatest importance. About 20 to 25 million cases of peas are canned each year.

Adaptation. The pea does best under cool conditions. Its seeds will germinate and make a more rapid growth under cooler conditions than most other vegetable crops. It seems that cool temperatures are essential to the highest yields and the best quality of product. Hot weather is decidedly detrimental to the pea plant. Young plants will resist light frosts; but, if the frosts come at flowering time, injury usually results.

Peas will grow on a wide variety of soils, provided drainage is satisfactory. A fertile loam soil is likely to be best under most conditions. An abundance of organic matter is of value. Fairly abundant rainfall is necessary for best production. If the rainfall is plentiful during the spring and summer, yields of high quality peas are more probable.

Varieties. Many new and improved varieties are being developed. The two general types of peas are the round smooth-seeded pea and the wrinkled pea. As a rule, the smooth peas are better suited for the early crop, as they are not so likely to rot if the soil is cold and wet. The wrinkled types are more commonly used for the later crops.

Early-maturing wilt-resistant varieties are strains of Alaska, Peerless, Thomas Laxton, and Wisconsin Early Sweet. Midseason wilt-resistant varieties are Green Admiral, Green Giant, Horal, Prince of Wales, Resistant Perfection, Roger's K, Senator, and Yellow Admiral. Nonwilt-resistant varieties grown by some canners are Surprise, Horsford, and Canner's Gem.

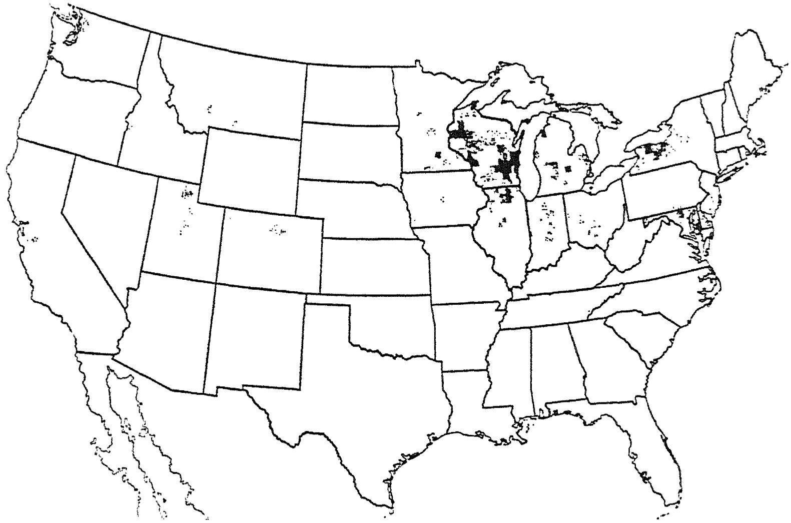


Figure 61. Outline map of the United States, showing the location of the pea-canning industry for the years 1925-29. Each dot represents an average of 100 acres per year.

Seeding. An abundance of fertility is desirable. Barnyard manure should be used, if available. Commercial fertilizers to supply the needs of the soil usually prove profitable. The fertilizer may be spread over the surface just before seeding.

Thorough seed-bed preparation to insure a mellow soil is essential. The destruction of weeds will aid greatly in promoting a good crop. Fall plowing may make it possible to seed earlier in the season, a factor of considerable importance.

If the soil is not already inoculated with pea-nodule bacteria, it is advisable to inoculate the seed before planting. The cost is small and the benefit may prove great.

Only the best of seed should be used. Choosing a good variety is important. Frequently, the canning company secures the seed and passes it on to the grower. The company is as interested as the grower in the use of superior varieties. In some cases the company employs scientifically trained men who devote a large part of their time in the improvement of existing varieties.

For the early crop the seed is planted as early as the soil can be worked. Light frosts do little or no harm to young seedlings. A grain drill or special pea seeder is best under most conditions. The peas may be broadcast, but more seed is required and a less uniform planting is possible. If the soil is loose, it is well to firm it with a cultipacker after planting.

The quantity of seed required for an acre varies with the variety, quality of seed, soil, and other factors. The usual rate of seeding is 3½ to 4½ bushels per acre. The varieties with large seeds require a higher rate of seeding than those with small seeds. Depth of seeding varies with soil type. On lighter soils seeds should be placed somewhat deeper than on heavy soils. As a rule 2½ to 3 inches is about right under average conditions.

Cultivation. As the crop is planted very early, it usually does not require cultivation. Soon after emergence, the plants cover the surface. Unless the soil is very weedy, little difficulty should occur. It is advisable to destroy weeds before planting and to seed the crop on land that is clean.

Rotation. Where the canning pea is grown, it is an important cash crop and is given the best possible place in the rotation. Generally the peas follow a cultivated crop. A typical rotation is: Clover, corn or potatoes, peas, small grain.

Under conditions of intensive farming, a crop such as beans follows the removal of the peas, thus producing two crops within one year.

Peas should not be produced on the same soil year after year, as this sequence is likely to result in what is commonly known as "pea-sick" soil.

Peas place the soil in excellent condition for succeeding crops. They increase the nitrogen content of the soil and aid in weed control. Following harvest, the soil is in excellent physical condition. Where winter wheat follows the peas, the soil is put in good condition with little effort.

Harvesting. The time of harvest is important, as the quality of the pea changes rapidly if harvest is delayed after the proper stage is reached. The best measure is the appearance of the pods.

These should be swollen and well filled with succulent peas. The vines will be fully developed and very succulent, indicating that the plants are in the full vigor of active growth. It is necessary that the fields be inspected each day as the time for harvest approaches. It is common for experts from the canning company to co-operate with the grower in determining the best time to harvest.

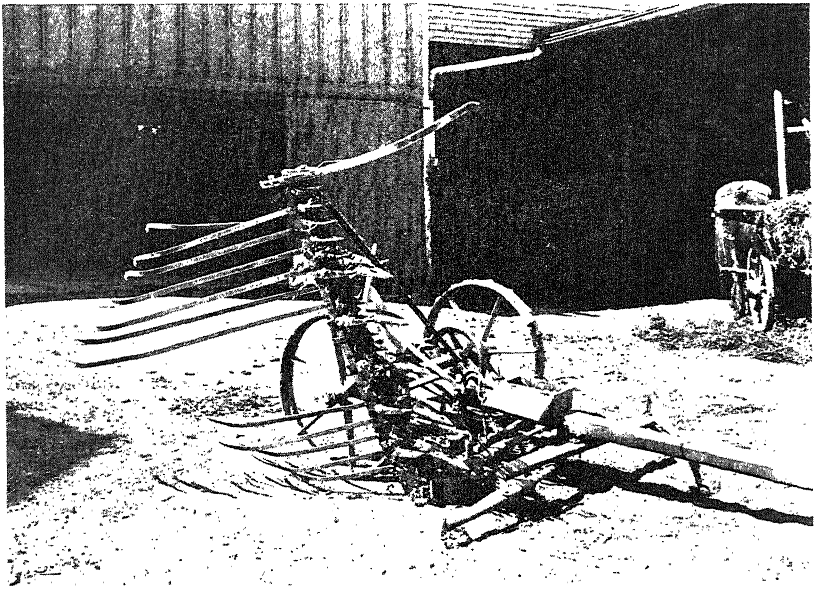


Figure 62. A mower filled with lifting guards and a swather or windrowing device as used for cutting peas.

Usually peas are harvested with an ordinary mower equipped with vine-lifting guards and swather. The guards attached to the cutter bar of the mower lift the vines and permit close cutting. The cut vines are rolled by the swather or bunching device, leaving them in a windrow. If the mower without the attachments is used, it is necessary to move the vines with a fork to prevent damage by the machinery on the next round.

The peas are usually mowed early in the morning or late in the afternoon. The crop is loaded directly on wagons from the swath or they may be placed in windrows with a side-delivery rake. The latter operation may cause some loss but saves labor. It is important that the vines be hauled directly to the canning factory or to the nearest field vining station.

Vining stations are located in the field at different points to speed the vining operations. The viner is a machine which separates the peas from the vines. The shelled peas are hauled by fast truck to the canning factory. It is necessary to avoid delays, as the quality of the crop is reduced rapidly if delays occur.

Yields of peas vary widely, but a production of one ton to the acre is not uncommon. Under favorable conditions, the pea crop is likely to prove profitable. In some years income may range up to $100 per acre. The risks usual to all crops may reduce the profits to the point where an actual loss occurs. A late frost, dry weather, insect or disease damage may destroy the crop. The canning pea, where it can be grown under contract, thus assuring a market, offers good possibilities of profitable production.

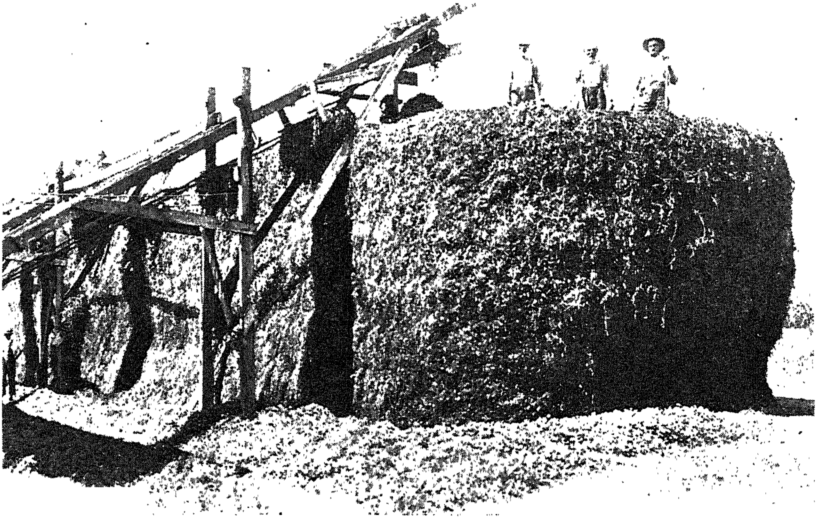


Figure 63. Stack of pea vines.

The vines and pods remaining after harvest provide valuable feed. They may be preserved by two methods, either by stacking or in silos. The stack is constructed at the viner; the silo, if used, is generally at the factory. The refuse is transported directly from the viner to the silo. The material placed in stacks forms a type of silage. Although losses are greater than when a silo is used, costs are less, as no investment is required.

Diseases. The principal pea diseases are wilt and pea-blight. The breeding of resistant varieties offers the best means of control. Wilt-resistant varieties are available, as indicated in the discussion of varieties. Crop rotation and the use of seed from disease-free fields will aid materially in disease control. The Wisconsin Station reports effective control of aphids by applying insecticides to infested plants at the time when the first flower buds appear. Both nicotine vapor and rotenone dust were effective in destroying the aphids.

Insects. The principal insect pests of peas are the aphid, or plant louse, and the pea weevil. The best control of the aphid is to practice crop rotation. The insect lives a part of the year on clovers and alfalfa. If the aphids become serious, it is well to avoid growing the peas near these crops. The weevil should be guarded against by proper storage to prevent their development. Supplies for planting should be examined to avoid the chances of infested seed.

Suggestive Questions

1. What crops are canned commercially in your state?
2. What happens to the sugar in sweet corn if it is not canned soon after picking?
3. When should peas be harvested for canning?
4. Why is hybrid sweet corn of especial value?

Suggestive Activities

1. If possible, visit a canning factory and write a report of the activities.
2. Prepare a crop rotation including sweet corn or peas.
3. From a study of feeding values compare pea silage with corn silage.

CHAPTER XVII

FRUIT GROWING

The production of fruits has, for the most part, become a specialized business. In the early days nearly every farmer in suitable regions established an orchard. It was regarded as an essential part of the farm much the same as the garden. Today the situation is far different. Most of the trees planted on these farms have long since passed out of existence. On most of these farms little or no fruit is produced. When the farmer desires fruit, he probably buys it from the local grocer. The fruit itself may have been produced a thousand or more miles away in an orchard where fruit-growing is the special business of the producer. It is probable that the passing of poorly-managed farm orchards may be due to the fact that better fruit may be purchased on the market and at scarcely more cost than would be incurred in maintaining a small orchard in profitable production of quality fruit. The farmer, therefore, saves cost, labor, and use of his land, while he may have plenty of fruit at no greater ultimate expense. Many farmers could produce limited quantities of fruit at a small cost.

Fruits may be divided into three major groups: (1) the tree fruits, including apples, pears, peaches, plums, and cherries; (2) the small fruits, including grapes, raspberries, blackberries, and strawberries; and (3) the citrus fruits, including oranges, lemons, and grapefruit. Although there are other fruits in these classes and fruits which do not fall into any of these groups, the most important types are included. We shall consider each of the types of fruit generally and individually.

The problems of commercial fruit production and marketing can not be treated here. The discussion must of necessity relate to the growing of a small orchard to provide fruit for the needs of the home.

The treatment of fruits and their production as outlined in this chapter is not intended so much for the commercial fruit grower as for the individual producer who still enjoys the luxury of having at hand the fruits of his own choice in sufficient abundance for his own use or for local sale.

TREE FRUITS

The choice of what tree fruits to grow is dependent upon many conditions. Not everyone is justified in producing tree fruits. Some types are not adapted to certain areas. Others may require more time and care than the grower can devote. If he undertakes the growing of fruit trees, he should give them proper care, so that the quality of the fruit should be high and his enterprise profitable. If he can not do so, then it will be better to avoid planting the trees in the first place and to utilize the area for an adapted crop that is likely to be profitable. Much land now in orchards would return more to their owners if the trees were pulled and the land planted to corn or cotton.

Adaptation. The first question, therefore, which the prospective grower should ask is, what fruits can be grown in the region? If he lives in the northern states, except under protected conditions, as east of Lake Michigan, he can not expect to grow peaches. If he lives in a section of low rainfall, then his choice of trees is limited, as most fruits will not succeed there without irrigation. It is best to check with the local agricultural experiment station as to suitable fruits, if one is a newcomer in an area. The observations and practices of long-time residents of the community should prove to be of value.

Most of the tree fruits produced for market are found in relatively few states. The following Table gives the production of the five most prominent states that ship most of the apples, pears, and peaches in the United States.

TABLE XXIX—Carload Shipments of Apples, Pears, and Peaches *(1936-37)*

Apples		*Pears*		*Peaches*	
Washington	28,397	California	6,956	California	7,952
Virginia	5,207	Washington	5,658	Georgia	5,448
West Virginia	3,563	Oregon	3,821	Colorado	2,077
Oregon	3,074	Michigan	539	South Carolina	1,358
New York	2,813	New York	382	Arkansas	1,168
United States	57,027	United States	17,720	United States	23,692

In those states or regions where the fruits are produced most abundantly, great commercial organizations and establishments create a vast industry for the growing, shipping, and canning and preserving of the various products, in much the same way as the canning of vegetables is conducted. By means of cold storage and refrigeration fruits may be shipped long distances and even held to spread over a much longer period of availability than would ever be possible otherwise. It may be said that fresh fruit is rarely out of season.

Choice of Varieties. The choice of varieties is important. One must choose those that are adapted to the desired use. If summer cooking apples are desired, then a certain group of varieties is available. If winter apples for storage are desired, then another group must be considered. The person growing even a small number of trees should consider the market demands, as it may be desirable to sell any surplus fruit that might be available.

The kind of fruits to be grown will depend also, at least in part, upon the extent of land available. If a city back lot is available, one may have to be content with a small tree, as a peach or a plum. If a somewhat larger area is available, an apple tree may fit into the program. As the area available increases, so also the possibilities of types of fruits increase. For the average farm orchard it is well to choose a variety of trees, including, as they are adapted, peaches, plums, apples, pears, and cherries. Within each group there is the problem of selecting varieties. With apples, for example, one will desire early apples for sauce, fall apples for cooking and eating out of the hand, and winter apples for storage to be eaten during the winter months. Not everyone will wish to grow all types and varieties, but the person who can choose a range will derive added benefit and pleasure. It is about as much trouble to grow two or three trees as several.

Locating the Orchard. On the farm the orchard is commonly located near the farmstead. Such a location has many advantages, as it makes it more readily available for care and harvest, and usually it interferes less with the general farm layout. If it is feasible to make a choice of the particular spot, it is desirable to choose an area that is gently rolling, so as to provide drainage of both water and air. Almost any slope may be used to advantage.

A well-drained soil is essential to good root development. As the trees need to develop rather extensive roots, it is important to avoid hard and impenetrable subsoils. Where these exist trees may be grown satisfactorily by blasting a pocket with dynamite. Peaches prefer sandy soils, while apples and pears are better suited to heavier soils. Sweet cherries do best on fertile loams, while sour cherries and plums are better adapted to lighter soil types.

Planting Plans. If several trees are to be planted, it is advisable to prepare a definite planting plan. This plan must consider the future size of the mature trees and ample space must be provided. The general tendency of most growers is to plant the trees too close. When they reach maturity they interfere with one another and make proper care more difficult. On a fertile soil a mature apple tree may require a space of 50 feet. Summer apples usually require less space. A suggested schedule of planting distances follows:

Apple	35 to 50 feet
Pear	25 to 30 feet
Peach, apricot, and sour cherry	20 to 25 feet
Sweet cherry	25 to 35 feet
Plum and prune	15 to 25 feet

In the planting of trees which require a large area for the mature tree it is advisable to interplant with so-called filler trees. In regions where adapted the peach may be grown to advantage. The sour cherry is planted as a filler by some growers.

Bush and other small fruits may be used, if the grower desires. The filler plantings have the disadvantage of adding to the difficulties of cultivating and pruning as they interfere with easy access to the trees. Pear trees should not be interplanted with apples because of the dangers from fire blight.

Several systems of planting may be used for spacing the trees. If only a few trees are grown, the plan of arrangement is unimportant. With larger orchards a definite arrangement is desirable. The principal plans are the square and the triangular or hexagonal systems.

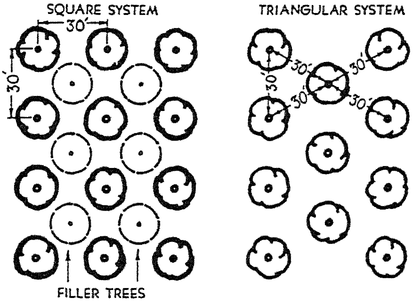


Figure 64. Systems for planting fruit trees.

The square system is easy to lay out. Trees are planted at the corners of squares whose size depends upon the type of trees planted. Temporary filler trees may be planted in the centers as illustrated above. The temporary filler must be removed before the trees become so large that they interfere with each other.

In the triangular system the trees are planted at the corners of equal-sided triangles. With this method it is possible to plant a few more trees per acre. No filler trees are planted with the triangular system. The method is not so easy to lay out as the square system and does not so readily permit cross-cultivation.

Purchasing Trees. It is well to purchase trees from a reputable nursery and to avoid bargain-price trees. Generally, there is something wrong with unusually low-priced nursery stock. All trees should be vigorous with well-developed root systems. The size of the tree is not so important, if it has a good root system. Trees from two to three years old are desirable under most conditions.

Planting the Trees. In most cases it is best to plant fruit trees in the early spring. A desirable guide is to plant just as soon as the land can be put in proper shape. The tree is able to establish itself during the cooler, more moist season of the year. It should be well established by the coming of warm weather. The earlier the planting, the greater the growth that may be expected during the first year. In mild climates trees may be set in the fall. The trees must be mature before they are moved.

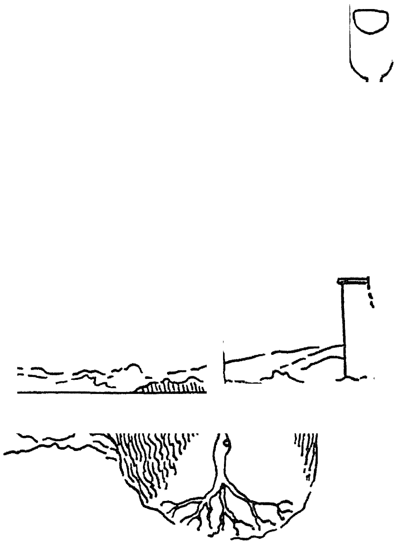


Figure 65. Using a planting board in setting a tree. The board was put in place with the center stake where the tree is shown. It was then taken up and the hole dug; then the board returned to its former position, as indicated by the end stakes (which have not been moved). The tree is in the position of the center stake.

The location of holes for planting is determined by measuring off the proper spaces as outlined above. Twine may be used to mark off the area and stakes set where the trees are to be planted. A planting board is of great value, if several trees are to be planted. Holes are dug larger than the root area so as to permit the tree to be set at least one inch deeper than it stood in the nursery. If the soil is variable, separate the topsoil from the subsoil and place the topsoil around the roots. Pack the soil by firming it with the feet. If the soil is dry, pour a pail of water into the hole before it is filled. After compacting the soil about the tree, leave a slight depression on the surface to catch rain which may fall. In case of continued dry weather after planting it, it may be advisable to water the trees until they are well established.

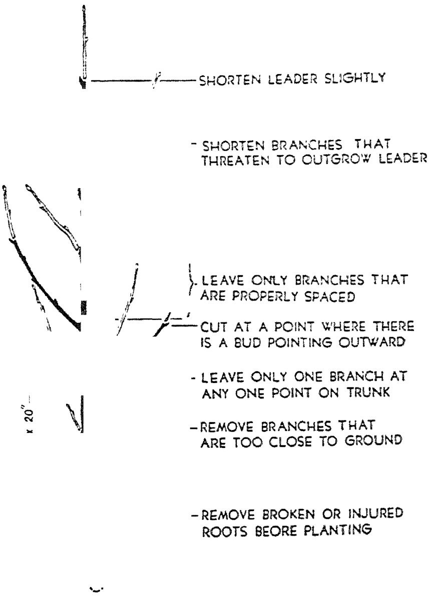

SHORTEN LEADER SLIGHTLY
SHORTEN BRANCHES THAT THREATEN TO OUTGROW LEADER
LEAVE ONLY BRANCHES THAT ARE PROPERLY SPACED
CUT AT A POINT WHERE THERE IS A BUD POINTING OUTWARD
LEAVE ONLY ONE BRANCH AT ANY ONE POINT ON TRUNK
20"
REMOVE BRANCHES THAT ARE TOO CLOSE TO GROUND
REMOVE BROKEN OR INJURED ROOTS BEORE PLANTING

Figure 66. Pruning a young fruit tree.

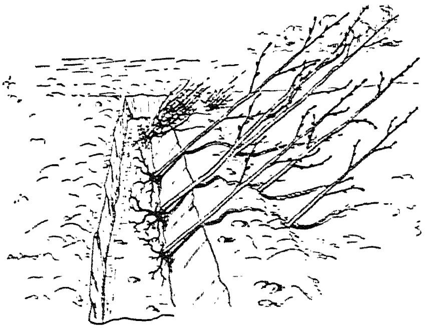


Figure 67. Heel in trees as soon as brought home.

The new tree, at the time of planting, should receive careful pruning. All broken or damaged roots should be removed before the tree is set. After the tree is set, a part of the top should be removed to compensate for the loss of roots. Cuts should be made to avoid leaving short, stubby branches which will affect the shape of the developing tree. The weak or crowded branches should be removed by cutting as close to the trunk as possible. Branches should be spaced so that they are three to six inches apart along the trunk. As far as possible, select those branches which have a strong, wide-angled crotch. Figure 66 illustrates the proper pruning of a young tree at planting time.

Heeling In. When the trees are received, unwrap the package and examine whether they are moldy or dry. If they are not in good condition, refuse to accept the shipment from the transportation company. It is well to dip the roots into a pail of water until they can be planted. If it is necessary to delay planting more than a few hours, the trees should be heeled in as soon as possible.

Heeling-in is the process of temporarily setting the trees in the soil until time for final planting.

Cultivation of Trees. The ground around trees should be cultivated to control weeds while the trees are small. Deep tillage is undesirable, as it may destroy valuable roots. If intercropping is practiced, cultivation is regulated by the filler trees or crops.

Tillage should be stopped in the middle of the summer or early fall, according to the section of the country. It is desirable to stop tillage to slow up the growth rate of the tree and hasten its hardening in preparation for winter. Some growers prefer to seed a cover crop. This crop uses excess plant food and moisture, but it acts as a covering to catch and hold snow. In the spring the crop may be worked into the soil to provide valuable humus and plant food to hasten vigorous summer growth.

Some growers, particularly in the East, permit their orchards to become sod after the trees are six to seven years of age. In the West, clean cultivation is practiced throughout the life of the tree. Where the orchard is on a steep slope, the use of a sod may be necessary to prevent serious erosion.

Plum and peach orchards do best if tillage is practiced throughout their life. Clean cultivation is of especial value in the control of certain insects, such as the plum curculio.

Pruning of Trees. The object of pruning young trees is to direct their growth, so that they will be strong and well shaped when mature. Too often the tree is permitted to develop too many branches which interfere with one another and thus results in a weak framework that breaks easily and reduces the life of the tree.

A leader should be chosen as the center shoot. The side branches are removed, so as to direct the shape of the tree and space the branches properly. All growth which interferes should be removed. The whip-like shoots arising on the trunk or larger branches are valueless and should be removed. All diseased or decayed portions also must be cut off.

It is essential that a good pair of pruning shears and a narrow-bladed saw be available for proper pruning. All cuts should be clean and as close to the trunk as possible. In no case should stubs be left. Any cuts larger than 1½ inches in diameter should be painted with white lead and linseed oil or asphalt paint.

It is best to prune trees when they are dormant. Late winter or early spring before growth starts is proper for most trees.

Spraying Trees. With the great number of insects attacking fruits, it is necessary to spray for their control. It is almost impossible to grow fruit without controlling the numerous insects which damage or destroy the crop.

It is not necessary that the small grower purchase expensive equipment. Of course it is desirable that the spray outfit be large enough to make proper spraying possible. On the small farm orchard it may be satisfactory to use a bucket sprayer or one of the knapsack types. Either type is inexpensive and will do satisfactory work if properly used. A somewhat larger type, the wheel barrow sprayer will provide for a fairly large number of trees. Of course, where a large orchard is involved a power sprayer is essential.

General sanitary conditions will go far toward controlling insects. The destruction of diseased fruits such as the windfalls which drop prematurely will aid. Clean tillage also destroys many of the pests which hibernate in the orchard litter. It must be remembered that to produce good fruit some spraying must be carried out.

The following Tables from the University of Minnesota Extension Bulletin 205 give a good setup for a pest control program for various fruits.

TABLE XXX—A SPRAY PROGRAM FOR CONTROL OF INSECTS AND DISEASES OF APPLES AND PEARS

Time of Application	*Material*	*Pests Controlled*
First spray (pre-pink) —Any time after the buds break until the flower buds are exposed but not yet separated in the cluster	5 quarts of liquid lime-sulfur or 5 pounds of dry lime-sulfur to 50 gallons of water	Apple Scab
Second spray (pink)—When the blossoms show pink	Same as for the first spray plus 1½ pounds of lead arsenate to 50 gallons of water	Scab, curculio, canker worm, and other leaf-eating insects
Third spray (calyx)—After most of the petals have dropped but before calyx closes	Same as for the second spray	Black rot, codling moth and those listed under the second spray

TABLE XXX—A SPRAY PROGRAM FOR CONTROL OF INSECTS AND DISEASES OF APPLES AND PEARS—*Continued*

Time of Application	*Material*	*Pests Controlled*
Fourth spray—Two or three weeks after the third spray	Same as for the second spray	Scab, black rot, codling moth, curculio, apple maggot (railroad worm), and leaf-eating insects
Fifth spray — About July 20	Same as for the second spray	Scab, black rot, apple maggot, and codling moth (second brood)
Sixth spray — About August 1 to 10. (For orchards badly infested with apple maggot in previous years or those not sprayed in previous years.)	Same as for the second spray	Scab, apple maggot and apple and leaf-eating insects

TABLE XXXI—A SPRAY PROGRAM FOR CONTROL OF INSECTS AND DISEASES OF PLUMS AND CHERRY PLUMS

Time of Application	*Material*	*Pests Controlled*
First spray — Just before the flower buds open	5 quarts liquid lime-sulfur or 5 pounds dry lime-sulfur plus 1½ pounds lead arsenate to 50 gallons of water	Plum pocket, leaf gall-mite, brown rot, and curculio
Second spray — Just after the petals fall	Same as for first spray	Brown rot, curculio, and shot-hole
Third spray — When the fruit is the size of a small pea	Same as for first spray	Brown rot, curculio, and shot-hole
Fourth spray — When the fruit of early varieties starts to color	5 quarts liquid lime-sulfur or 5 pounds dry lime-sulfur to 50 gallons of water	Brown rot and shot-hole

The time of application will vary somewhat in different parts of the country. The important point is to make certain that spraying is done at the proper time. A few days' delay in application renders the treatment of much less value.

TABLE XXXII—CONTROL OF PEACH PESTS

Time of Application	*Material*	*Pests Controlled*
Dormant spray — Applied in fall after leaves fall or early spring before buds are swollen	6 gallons of commercial liquid lime-sulfur in 50 gallons of spray or 1½ gallons of Bordeaux in 50 gallons of water. Used where scale is very abundant	San Jose scale and leaf curl

TABLE XXXII—CONTROL OF PEACH PESTS—*Continued*

Time of Application	*Material*	*Pests Controlled*
First summer spray—10 days after bloom. When flower parts are dropping from young fruits	1½ pounds lead arsenate and zinc sulfate-lime in 50 gallons of spray	Plum curculio
Second summer spray—10 days later	Same as above	Plum curculio, bacterial spot, and scab
Third summer spray—2 to 3 weeks later	Same as above	Same as above
Fourth summer spray — One month before harvest	Same as above	Plum curculio and bacterial spot
Fifth summer spray—3 weeks before harvest	3 pounds sulfur to 50 gallons of spray. No lead or lime is used	Brown rot
Sixth summer spray—1 week before harvest	Same as above	Same as above

It is not always necessary to apply all the above sprays, but where the crop is grown commercially, one can not afford to take chances by omitting an essential spray. Dusts have been used to advantage on peaches. A good dust is a mixture of 80 parts of dusting sulfur, 10 parts of hydrated lime, and 10 parts of lead arsenate. This is applied about every two weeks. Lead should not be applied less than 3 weeks before harvest. The addition of 5 per cent by weight of mineral oil has proved of value.

TABLE XXXIII—CONTROL OF INSECTS AND DISEASES OF CHERRIES

Time of Application	*Material*	*Pests Controlled*
	Sour Cherries	
Dormant spray	Lime-sulfur 6 gallons to 50 gallons of spray or dormant oil 3 gallons lubricating oil emulsion to 50 gallons of spray	Scale insects
First summer spray	1 gallon lime-sulfur to 50 gallons spray	Brown rot, leaf spot, curculio, and slug
Second summer spray—If weather is damp after first summer spray, apply 10 days later	Same as above	Same as above
Additional sprays — Just before harvest	1 gallon lime-sulfur to 50 gallons spray	Leaf spot

TABLE XXXIII—Control of Insects and Diseases of Cherries—*Continued*

Time of Application	*Material*	*Pests Controlled*
	Sweet Cherries	
Just before blossoms open	5½ gallons lime-sulfur ½ pint nicotine sulfate to make 50 gallons of spray	Scale, aphids, brown rot

For later sprays follow schedule for sour cherry.

PROBLEMS WITH SPECIFIC TREE FRUITS

THE APPLE

Varieties. It is impossible to list all varieties, but a few of the important ones are listed according to sections in the following Table:

TABLE XXXIV—Apple-Producing Sections and Varieties

Section	*Summer and early fall*	*Late fall and winter*
California	Gravenstein	Yellow Bellflower, Rome, Delicious, Winesap, King David
Inter Mountain Area		Jonathan, Delicious, Winesap
Pacific Northwest	Yellow Transparent	Delicious, Jonathan, Winesap, Rome Beauty
Ozarks	Yellow Transparent	Delicious, Jonathan, Stayman Winesap, Ben Davis
Southern Indiana and Illinois	Yellow Transparent	Jonathan, Winesap, Stayman Winesap, Ben Davis, Rome Beauty
Virginia—West Virginia Area	Yellow Transparent, Oldenburg, Wealthy, Northwestern Greening, Rambo	Delicious, Yellow Delicious, Winesap, Stayman Winesap, Rome Beauty, Jonathan, Black Twig, Grimes, Ben Davis, York
New Jersey Coast	Yellow Transparent, Oldenburg, Wealthy	Winesap, Stayman Winesap, Delicious, Jonathan, Grimes, Baldwin
Michigan Area	Wealthy	Greening, Jonathan, Fameuse, Delicious, Northern Spy, Baldwin
North Central States	Duchess, Yellow Transparent, Beacon, Wealthy	Patten's Greening, Northwestern Greening, Jonathan, Winesap
New England States	Wealthy, Gravenstein	Delicious, Fameuse, McIntosh, Northern Spy, Baldwin, Rhode Island Greening
New York Area	Oldenburg, Wealthy	McIntosh, Rhode Island Greening, Baldwin, Northern Spy

The best method of choosing varieties is to check with the newest developments of the agricultural experiment station and to learn from other growers which varieties are most popular.

Management. We have discussed the early pruning of the young tree. If the tree is started properly, the problems of care are reduced. If the modified center leader form is followed, five to seven branches are spaced about this leader. Interfering branches should be removed, so as to permit entrance of light and make it easier to harvest the fruit.

Low heading of trees makes it possible to spray and harvest the fruit with less labor. It is necessary to keep the branches high enough to be out of the way of tillage equipment if clean cultivation is practiced.

THE PEAR

The pear is grown more as a commercial crop than the apple.

Varieties. The production of pears is more limited than that of apples. Most of the pears of the country are produced in a few districts.

TABLE XXXV—PRINCIPAL PEAR-PRODUCING SECTIONS AND VARIETIES

Section	*Varieties*
New York, New Jersey	Bartlett, Anjou, Seckel
Delaware, Maryland	Kieffer
California	Bartlett
Pacific Northwest	Winter Nelis, Anjou, Bartlett, Seckel

Management. The pear tree may be left to develop its natural shape or it may be trained to a set form. In the West it is more common to train the tree to an open-headed or vase form. It is believed that this form permits easier control of fire blight.

THE PLUM

The plum is grown extensively where the apple or peach is not so well adapted.

Varieties. The more hardy varieties are derived from the native species. As a rule, they are not so desirable for eating out of the hand as the Japanese or European varieties.

TABLE XXXVI—IMPORTANT VARIETIES OF PLUMS

From Native Stock	*European*	*Japanese and Hybrids*
Ames	Bradshaw	Abundance
De Sota	Damson	Burbank
Ember	Italian Prune	Kelsey
Underwood	Lombard	Santa Rosa
	Monarch	

If one lives in a dry or a cold region or where there is a combination of this diversity of weather, he probably will find the native varieties to be more adapted.

Management. With a proper start, the plum tree is easily trained. The modified leader system is suitable in the training of this tree. Japanese varieties should be pruned rather severely. A certain amount of thinning is necessary to prevent a compact matted growth in most varieties.

THE PEACH

As indicated in the plans for orchards, the peach, where adapted, may be interplanted with apples. The peach will not withstand low temperatures, and is, therefore, limited in its distribution.

Varieties. Peach varieties change rapidly, as breeding work develops new ones. A few of the old varieties, however, are more or less standard. Most of the peaches of the country are produced in the South and West, although the Lake States and the important apple regions produce many high-grade peaches.

TABLE XXXVII—Peach Regions and Important Varieties

Region	*Varieties*
Eastern peach-growing states	Belle, Carman, Elberta, J. H. Hale
Colorado	Belle, Elberta, Heath
Southeast	Belle, Carman, Elberta, J. H. Hale
California	Elberta, Lovell, Muir
Pacific Northwest	Elberta, Rochester

Management. As peaches are produced on one-year-old wood, it is desirable to prune rather heavily to stimulate new growth, but too much pruning of the young tree may delay its growth. After the tree is established, more severe pruning may be desirable. The tree should be headed low, so that much of the harvesting may be done with a low ladder or while standing on the ground. If a frost has destroyed the crop, it is well to prune to balance. Too heavy pruning may result in injury to the tree.

THE CHERRY

The cherry is suited to regions having mild winters. It is somewhat more cold-resistant than the peach.

Varieties. Not so many varieties of cherries are grown as of some other fruits. The sour cherries are more hardy than the sweet varieties.

TABLE XXXVIII—PRINCIPAL REGIONS AND IMPORTANT VARIETIES OF CHERRIES

Section	*Varieties*
East of the Mississippi River and north of the Ohio	Montmorency, Early Richmond sour cherries
Pacific Northwest	Bing, Lambert, Napoleon sweet cherries

The sweet cherry varieties are not long-lived when grown in regions to which they are not adapted.

Management. The cherry requires the least pruning of all fruit trees. Both the sweet and the sour cherry trees may be grown by the modified leader system. The treatment varies in different sections. After the trees are well established, pruning to maintain shape and to avoid overcrowding is desirable.

SMALL FRUITS

The members of this group of fruits are grown far more extensively than the tree fruits. Many a city dweller with a small back lot could not think of producing apples or pears, but he may raise a few grapes, currants, raspberries, or small fruits. Such culture may aid greatly in balancing the family budget, while supplying important healthful food. The small fruits are easy to grow, usually not requiring the care so essential to tree fruits.

THE RASPBERRY

Most of the raspberries produced in this country are grown east of the Dakotas, north of the Ohio River, in the northeastern quarter of the United States, and in the Pacific Coast States. The plant prefers a cool growing season and does not produce as well where hot summer temperatures prevail.

Varieties. There are three principal types of raspberries: the red, the black, and the purple varieties. The principal varieties of red raspberries are Chief, Latham, Newburgh, and Van Fleet. Leading varieties of black raspberries are Cumberland and New Logan. The principal variety of purple raspberries is Potomac. The purple varieties are not as important as the black or red.

Management. If possible, the small raspberry planting should be near the house for convenience. Well-drained soil is essential. A slight slope is ideal on most soils. Care should be taken to keep at least 50 feet away from large trees which may sap the soil moisture.

Almost any type of soil is suitable for red raspberries, if moisture is available. On light soils it is advisable to plow under green manures to improve their water-holding capacity.

Planting. Plantings may be made in the fall or the spring. Most growers prefer spring planting. The plants are set about two inches deeper than they grew in the nursery. If space is available, spacing of plants should permit cultivation with machinery. On smaller areas it may be better to set the plants closer and cultivate by hand. In the hill system of planting the usual spacings are 4½ by 6 feet or 5 by 5 feet. This space permits cross-cultivation and reduces hand tillage to a minimum. The staked-hill system is popular. By this method a stake is driven in the center of each hill. The stake should be long enough to extend about five feet above the surface. Five to eight of the strongest canes are tied to the stake as illustrated. Ordinary binder twine may be used for this purpose. It is important that the canes be tied securely to prevent movement of the plants. Remaining canes are cut off at the surface and the hill is confined to the five to eight canes selected each year.

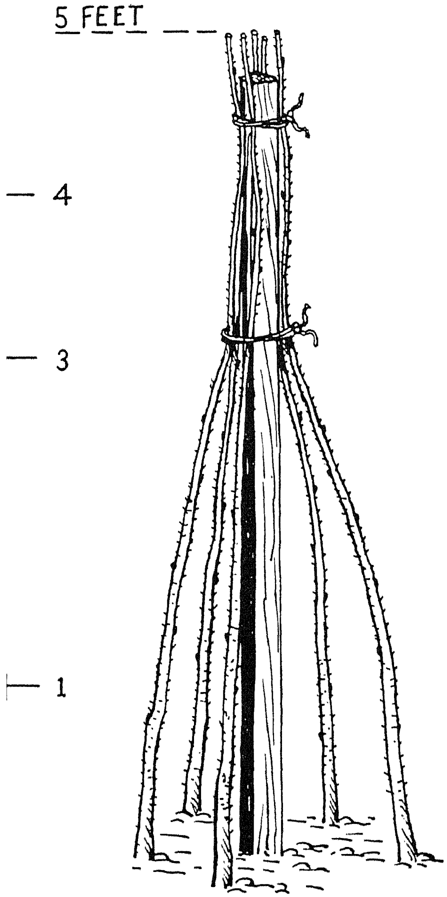


Figure 68. Staked-hill system.

In the hedge-row system the plants are permitted to send up suckers which eventually make a continuous row. With this method the rows are 6 to 7 feet apart, with the original plants spaced 2½ to 3 feet apart in the row. Soon the suckers fill in the row. The row should be kept narrow—not to exceed 12 inches.

Black raspberries develop new canes from the crowns only. They should be confined to hills. Either 5 by 7 feet or 6 by 6 feet is a common spacing.

Plants may be placed in furrows or they may be set with a spade. The spade is suitable for small plantings. After the plants are set, they should be headed back, if the nursery has not already done so.

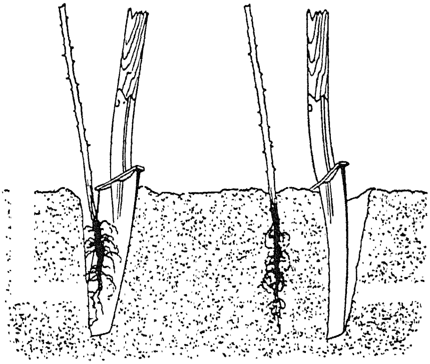


Figure 69. Setting plants with a spade.

Pruning. The raspberry roots are perennial, but the canes live but two years. It is necessary that pruning be done, so as to encourage the development of new canes as the old ones are removed. As soon as a cane has borne its crop, it should be removed. The young canes which will bear next year's crop will then have a better opportunity to develop.

Raspberry canes should be shortened with a pair of pruning shears to about 4½ to 5 feet. In the spring, the tips may be cut back without serious loss of berries. The effect is to produce larger fruit.

Black raspberry canes may be pinched back during the growing season when they have attained a height of 18 to 24 inches. This pruning stimulates side branches, which may be shortened to 12 to 18 inches the next spring.

Winter Protection. Winter protection is necessary where the winters are very severe. Most red raspberry varieties are hardy. The black raspberry is more likely to suffer winter injury than the red. Care must be taken to avoid breaking the canes. Soil may be used, if the winters are not too wet. Straw or strawy manure may be used to advantage. The covering must be removed early in the spring after the frost is out of the soil.

Diseases. The principal disease of raspberries is anthracnose. The disease is recognized by small purplish spots on the young canes. Later, these spots become oval shaped with a sunken grayish center and purple edge. Resistant varieties and the planting of disease-free stock are to be recommended. Bordeaux mixture as a spray is used where the infection is heavy.

BLACKBERRIES AND DEWBERRIES

The blackberry is not widely grown. The Lucretia dewberry is one of the most popular varieties. The Youngberry and the

Loganberry are important varieties in the South and in the Pacific Northwest. The Boysenberry, a similar type of plant, is becoming of increased importance because of its high quality of fruit.

Blackberries and dewberries are handled somewhat the same as black raspberries. Old canes are removed and burned after harvest. New shoots are headed back to encourage side branches. If feasible, it is desirable to use a wire trellis to facilitate care of the crop and make the fruit more accessible for picking. Where the winters are cold or dry, winter protection is advisable much as for the raspberry.

CURRANTS AND GOOSEBERRIES

As these crops are closely related, they may be considered jointly. Their general adaptation and management is very much the same. Currants and gooseberries do best where the climates are moist and cool. Accordingly, they are found primarily in the northern half of the United States east of the one hundredth meridian. Their ability to withstand low temperatures has led to their spread far to the north.

Since both currants and gooseberries spread the white-pine blister rust, neither crop should be planted in regions where pine forests are located.

Growing Currants and Gooseberries. These plants may be grown where it is cool and moist. Well-drained fertile soils are best.

The currant is propagated by cuttings made from vigorous shoots of the current season. These are cut in the fall after the leaves drop. Commonly, the 8 to 12-inch cuttings are stored in sand, bottom end up in a cool cellar. Cuttings are set 3 to 6 inches apart in the nursery in the spring. Not more than two buds are left to a cutting. After one or two years the plants are large enough to set in the area reserved for permanent planting.

Gooseberries are started by mounding the soil about the mature plant. The plant is cut back heavily before growth starts in the spring. By the middle of the summer numerous shoots will be started. These are mounded by pulling the soil at least halfway to the ends of the branches. By fall, roots should be developed on the mounded branches. The rooted sections are cut off and transplanted to the nursery for a year. Some varieties may be rooted by cuttings, as outlined for the currant, but this method is not generally as dependable.

Both currants and gooseberries may be taken from the nursery and planted early in the fall to insure establishment before winter. Plants are usually set in the spring, if they are purchased from nurseries.

Cultivation. Cultivation is essential to control weeds. Care must be taken to avoid damaging roots which are near the surface. The bushes may be set 5 feet apart in rows 7 to 8 feet apart. The spacing varies with the method of cultivation.

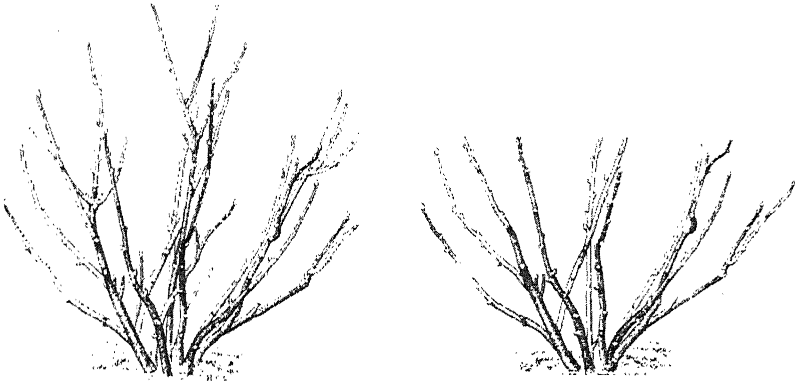


Figure 70. Currant bush before and after pruning.

Pruning. Currants and gooseberries must be pruned for best production. Red or white currants when one year old should have the weak shoots removed, leaving six to eight strong shoots. These types produce their fruit at the base of one-year-old wood and on spurs on older wood. Pruning of mature bushes should be to remove all branches more than three years old.

THE GRAPE

The grape occurs naturally in nearly every part of the world, but nowhere are found more species than exist in the United States. This fact indicates that the adaptation of the grape to our conditions is general. While commercial grape production involves many problems, home culture is within the reach of nearly everyone. The grape is easily grown, has relatively few pests as compared with the apple or pear, and requires but little space for successful propagation.

While the grape may be produced in nearly every section, only a few areas produce large quantities for market. The principal producing states are listed in the following Table.

TABLE XXXIX—Carload Shipments of Grapes (1937)

California	35,377	Pennsylvania	365
Michigan	726	Arkansas	133
New York	376	United States	37,352

Varieties. Many of our varieties of grapes are native to America. The wild fox grape *(Vitis labrusca)* has been used in crosses with the European grape *(Vitis vinifera)* to produce several valuable varieties. The hybrids are found mostly in the eastern part of the country, while the *vinifera* species are more common in California. In the South is found the species *Vitis rotundifolia*, often referred to as Muscadine grapes.

Varieties must be adapted to the section where grown. Where the winter seasons are not too cold, as in the latitude of Iowa, the Concord, Moore Early, and Worden are blue grapes of quality. The Delaware (red) and the Niagara (white) are grown in much the same region. Catawba, another red variety, is popular with some growers. By far the greatest production of market grapes in the East is of the blue varieties, chiefly Concord. Where it is colder and the seasons are more severe, the Concord and the other varieties named must be given winter protection. Here the lower quality grapes Beta, Alpha, and Hungarian are grown. A promising variety, Fredonia, has attracted considerable favorable comment.

Of the Muscadine grapes of the South, Thomas, Luola, Flowers, and Hunt are leading black varieties. Scupperrong, a white variety, is grown to some extent.

Grape-growing in California is a highly specialized industry. Some of the leading varieties are Agadia, Flame Tokay, Malaga, Muscat Hamburg, and Sultana.

Production Management. Grapes are propagated from seed, cuttings, layering, or grafting. Seedlings offer the possibilities of producing new varieties. Probably most grapes are propagated by cuttings. Usually stems from 8 to 20 inches long are cut from young, well-matured wood. The drier and hotter the climate, the longer the cutting should be. Cuttings are bundled and heeled-in or buried in trenches with the butt ends up, and covered with three to six inches of soil. Where the climate is cold, the cuttings may be stored in moist, not wet, sand in a cool cellar. In the spring the cuttings are set in slanting trenches 3 to 4 feet apart. After one year the young plant may be transferred to its permanent location. Many growers prefer to leave the plants for two years in the nursery, thus securing more vigorous vines.

Plants started by layering are usually successful. This method is common in the South. During the summer, canes from last season's growth are placed in a trench about 3 inches deep and fastened to the bottom of the trench. Roots will form and separate plants are obtained by cutting them apart. To expedite root formation a small cut should be made in the cane opposite each bud. Plants are set into the place of permanent location.

The average grower will not use the grafting method since it is not so easily followed by one who is inexperienced.

A fertile, well-drained soil is best for grapes. Many vineyards are planted on rather rolling soils. Where plant food is available, these may be highly successful.

Plants are spaced according to the room available and method of cultivation. Planting 8 feet by 8 feet apart is satisfactory under many conditions. This spacing requires 680 vines per acre. Commonly, the rows are arranged to permit cross-cultivation at first. Later, if a trellis is used, cultivation is possible lengthwise only. Where but a few vines are planted, they may be trained on porches, fences, trees, and other objects. Many people make a splendid shaded arbor by properly training the grape. It is common to use a trellis composed of posts and smooth wire. Either two or three strands of No. 10 or No. 12 wire are fastened to posts spaced 24, 40, and 56 inches respectively, from the ground.

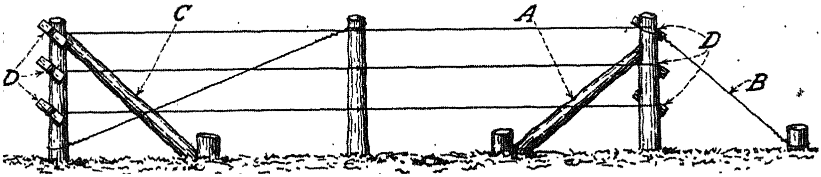


Figure 71. Diagram of an ordinary trellis showing the braces (A, B, C) and devices (D) used for tightening the wires.

Pruning. Grapevines are pruned to produce new wood, as the crop is produced on new growth each season. It is necessary to remove useless wood that has fruited; to select only a few of the straight canes to bear fruit; and to limit the old wood to that necessary to carry the new canes. If the vines are likely to winterkill, it is necessary to prune them, so as to permit winter covering in the fall. Hardy vines are pruned either in the fall or the spring. Most growers prefer fall pruning.

The spur, stool, or short pruning system is general in California with the heavy growing varieties found in that section. This system permits the body of the vine to grow to the desired height and shoots from the two uppermost buds. The resulting canes are cut back in winter to spurs of two eyes each. The process is repeated the following year. After about five years the vine consists of a trunk with four or five arms on each of which a cane has been cut back to a spur.

Training the Vines. Many systems of training grapes are available. The so-called Kniffin system is popular in many parts of the East. As illustrated, a six-cane Kniffin system provides for a regular distribution of fruiting wood favoring the highest production of quality fruit. In the four-cane Kniffin system, two wires are used and four branches are left.

Insects and Diseases. While several insects and disease pests attack the grape, they are not so general as with most fruits and will not be discussed here. Where grapes are produced commercially the problems of pests are likely to be greater.

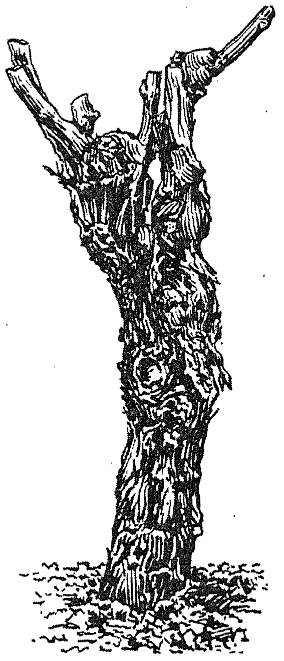


Figure 72. A pruned vine in its fifth year, showing the method of training by the spur, stool, or short system.

THE STRAWBERRY

The strawberry is grown for home use in every state of the Union. It will succeed under a wide variety of conditions. With a dozen plants the grower can produce enough berries to make it worth while. While the strawberry crop is grown commercially in many areas, here we shall consider it from the viewpoint of the home producer who desires fresh fruit early in the season and enough surplus for canning and preserving.

Types and Varieties. Most strawberries are of the summer type. They bear a heavy crop early in the summer, and discontinue production until the following year. Recently, there has been increased interest in the so-called everbearing strawberry. The plants bear at the usual time, enter a period of rest, and, in the late summer, start bearing a second crop. Usually, where adapted, production continues until cold weather. The everbearing types are better suited to the cooler sections of the country than farther south.

The principal varieties of common, or June, strawberries are Dunlap, Premier, Dorsett, Fairfax, Aroma, Chesapeake, and Klondike. The leading everbearing varieties are Progressive, Gem, Mastadon, Champion, and Wayzata. The Wayzata variety, one of the more recent developments, is one of the best varieties developed. Most varieties of strawberries have perfect flowers, that is, they do not require crossing with other varieties. Some varieties are like plums; crossing is obligatory to fruit setting. Most of the better varieties have perfect flowers and successful crops may be produced with but one variety.

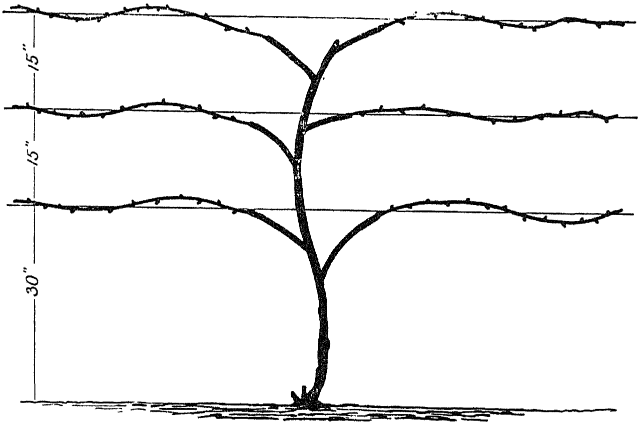


Figure 73. The six-cane Kniffin system for training grapevines.

Growing. Any fertile, well-drained soil will produce strawberries if sufficient moisture is available. A south slope will give somewhat earlier berries, but there may be a disadvantage in case of late spring frosts.

A well-prepared soil is essential. It is better to avoid sod lands, as these may be infested with grubworms, a serious pest to the strawberry. It is valuable to plow manure under. Fall plowing will enable one to plant early in the spring, the desirable time in most areas. In the South it is common to plant in August or early fall. The early spring planting enables the plants to become well established and insures a full crop the following season.

Several planting systems may be followed. The most common are the matted row, the hedge row, and the hill systems. In the eastern states the matted row is most popular. Rows are about 4 feet apart with plants 18 to 24 inches apart in the row. The wide spacing permits tillage with machinery and reduces hand labor. The plants are permitted to form runners until the row is a solid mat, but should not be permitted to spread too wide so as to interfere with tillage and harvesting. The use of straw between the rows keeps the berries clean and helps to check weeds and conserve moisture.

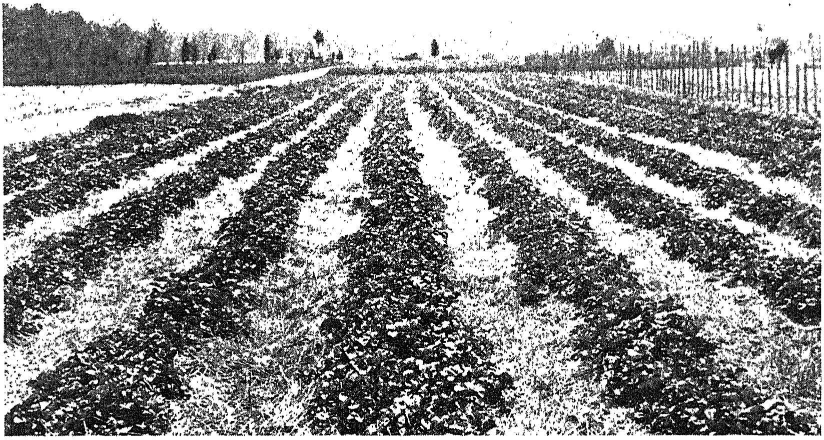


Figure 74. A well-mulched strawberry planting.

In the hedge-row system the plants are in rows, but are kept apart; that is, the runners are hoed out. More labor is required than in the matted-row system.

In the hill system the plants are spaced so that cross-cultivation is possible. The spacing varies from 12 to 15 inches for hand tillage to 2½ to 3 feet for machine cultivation. All runners are removed and the mother plants become capable of producing a large, uniform type of fruit.

Plants are set so as to avoid covering the crown and deep enough to permit freedom of the roots. A portion of the straggling root ends and of the leaves should be pruned before planting. Only one or two of the smallest leaves should be left.

With both types of strawberries it is best to remove early blossoms. The new planting of June-bearing varieties will be weakened if allowed to bloom and produce fruit the first year. Where adapted, the everbearers may be permitted to bear fruit late in the summer of the first year, if they were planted early in the spring.

Winter Protection. It is advisable in most areas to cover the plants in the winter. Straw is best for this purpose, as it does not mat so as to smother the plants. The straw is applied after the first hard frost. If covered too early, injury is likely to occur, as the plants will make a weak tender growth under the straw. The straw is removed in the spring before growth starts. It may be used as a mulch between the rows after removal from the vines.

Period of Production. If the bed is free from weeds and is productive, it may be left for an additional season. Sometimes the berries produce as many as three seasons or more. Usually, it pays to start a new bed about every other year. Thorough tillage to reduce the strip of plants to a narrow row 10 to 15 inches wide is desirable. It is satisfactory in some cases to cultivate thoroughly, leaving the most vigorous plants to carry on the following season.

Diseases and Insects. If diseases and insects are not epidemic, the use of the original bed may be extended for several years. It is to be remembered that, as with most other crops, it is best to practice rotation. Old beds should have the tops mowed, removed and burned to aid in the control of diseases and insects.

CITRUS FRUITS

The so-called citrus fruits, including oranges, lemons, and grapefruits are very important in a few sections of the country. Most of the citrus fruit is produced in the south Pacific Coast, the Southwest and in the Gulf States. While not many states produce these crops, they are of great value. Nearly every person consumes more or less of these fruits. Not many years ago they were regarded as luxuries; today they are recommended as essentials in the human diet.

TABLE XL—Carload Shipments of Citrus Fruits *(1936-37)*

Oranges		*Grapefruit*		*Lemons*	
California	42,486	Florida	20,400	California	14,912
Florida	36,281	Texas	13,894	Arizona	4
Texas	1,755	California	1,078		
United States	80,821	United States	36,418	United States	14,916

It is impossible within the scope of this text to cover the detailed phases of all citrus fruits. An attempt will be made to touch upon the principles involved in the growing of oranges and lemons.

ORANGES AND LEMONS

Most of the oranges produced in the United States are grown in two states, California and Florida. Both states have the mild winter temperatures which usually limit the production of this important fruit.

Varieties of Oranges. There are many varieties of oranges. The more important ones grouped as to season are:

Early	*Midseason*	*Late*
Parson Brown	Temple	Valencia
Hamlin	Pineapple	Lue Gim Gong
Satsuma	Jaffa	King
Connon's Early Improved Seedless	Homosassa	
	Ruby Blood	
	St. Michael Blood	

There are great differences between the varieties of oranges grown. The quality of the fruit is dependent upon the variety and in part upon the soils and other environmental conditions under which it is grown.

Varieties of Lemons. Some of the principal varieties of lemons are Eureka, Everbearing, Genoa, Lisbon, Otaheite, Ponderosa, Rough, Sicily, Sweet, and Villafranca.

Soils for Citrus Fruits. The citrus fruits may be grown on a wide range of soil types, provided there is sufficient plant food and good drainage. Oranges and lemons do poorly on heavy, wet soils. Some very light soils produce good fruit after proper fertilization.

Growing the Crop. A location with good air drainage is desirable. Late spring frosts are likely to cause great damage even in areas where the orange or lemon is well adapted.

Seedlings may be used to start the crop, but probably the small grower will find it desirable to purchase budded nursery stock of known varieties. The young trees are set much the same as outlined previously for apples. While the distances between trees will vary with environmental factors, a common distance of 25 by 25 feet is suitable on light soils while a 30 by 30-foot spacing is used more often on heavier soils where the trees tend to become larger. Planted by the triangular system a 25 by 25-foot spacing gives about 64 trees to the acre. Interplantings may be made with smaller growing trees until the orange or lemon trees become large.

Frequent cultivation is necessary to conserve moisture. Fertilizers should be added in the spring of the year. On light soils applications should be made at regular intervals. Usually, on most soils a highly nitrogenous fertilizer is best. Trees five years old will require about 7 to 10 pounds of fertilizer per tree and mature trees about 30 to 40 pounds. This amount will vary, naturally, with different soils.

Trees are pruned to maintain well-spaced branches. Interfering branches and dead wood must be removed. Sunlight must be admitted to promote the proper coloring of the fruit.

The fruits are removed from the tree with clippers. The stem should be cut as short as possible. Care must be exercised to avoid cuts and scratches on the fruit, as these are likely to result in decay. The picked fruit must be handled with care to avoid unnecessary bruises.

Figure 75. A grove of Valencia oranges about ready to bear.

The student who is interested in more detailed treatment of citrus-fruit growing will find it advisable to refer to special bulletins and books dealing specifically with this subject.

Suggestive Questions

1. Why is it important that the newly-planted tree be pruned as soon as set out?
2. When should one heel-in his plants?
3. Why is it necessary that more than one plum tree be in each orchard?

4. Why should strawberries be mulched in winter?
5. Why is it inadvisable to grow currants and gooseberries in pine forest regions?
6. Explain the importance of severely pruning grapes.

Suggestive Activities

1. Prepare a chart of the fruits that may be grown in your community.
2. Visit a farm orchard and prune fruit trees or vines.
3. Describe the principal varieties of apples suited to your section.
4. Prepare a spray chart for use on your home farm.

CHAPTER XVIII

SPECIAL SOIL TYPES

In the United States there are many types of soil. Not all farmers are fortunate enough to have farms whose soils are basically fertile and productive. In the early history of our country it was possible for the farmer to choose only the best farms. Today, with no new lands to homestead, many farmers find it necessary to live upon the poorer, or so-called marginal, lands. Many of these districts are suitable for crop production, provided certain precautions are taken and special care is given to the soil. It is desirable to discuss these special types, as their proper care and management involve principles that may differ from those applying to ordinary soils.

PEAT SOILS

Considerable acreages of soils are classed as peat. A peat soil is one in which the vegetable matter has not undergone complete decomposition. It is, naturally, therefore, very rich in organic matter but usually is lacking in the mineral elements. Peat soils are high in nitrogen, although this nitrogen may be unavailable to plants. Peat soils are in the process of soil-making. They are loose and spongy, thus being very retentive of moisture, a factor which makes them slow to warm up in the spring and subject to frequent frosts.

Peat Soil Areas. Most of the peat soils are found in the northern sections of the United States. Minnesota, Wisconsin, and Michigan have large acreages of peat soil.

Types. Peat soils may be classed as deep and as shallow. The deep peats are those four feet or more in depth. Usually these deep peat soils can not be used for agriculture. If left undisturbed, they may become valuable in a period of several hundred years.

The shallow peats offer the greatest promise. These are reclaimed by first draining the land to get rid of the excess water. Following drainage the peat mass shrinks and settles. This layer may be compacted by rolling with a very heavy roller. If it is possible to plow through the peat and bring up the underlying mineral layer, the peat and the soil may be mixed and thus made capable of growing crops successfully.

Burning Peat. In some sections of the country the farmers burn the peat. The ashes are then incorporated with the underlying soil and often a fertile soil results. It is probable that most of these soils are likely to be deficient in mineral elements which must be applied in the form of commercial fertilizers to make crop growth economical.

Peats Are Acid. By its very nature peat soil tends to be acid. The large amount of plant material which has decayed produces an acid reaction. This condition must be corrected unless the underlying soil is rich in calcium. If so, tillage will reduce the acidity and make it possible to grow lime-loving crops.

Fertilizers. If peat soil can be reduced to where it is not a mass of fibrous matter, it may be used to grow crops. Most peat soils need lime, which may be applied as ground limestone to correct the acidity.

Phosphorus and potassium fertilizers are likely to prove beneficial. When the farmer is uncertain as to the needs of the soil, he may try out each fertilizer on a strip and determine by the crop response whether to apply more or less. Because peat soils vary widely, a soil analysis may not be reliable. The test of crop response is likely to be a better gauge of requirements.

Barnyard manure, particularly horse manure, is of value on peat. The manure adds bacteria to the peat and these hasten the decomposition and render the plant foods available within a shorter time.

Drainage. Before one can hope to farm a peat soil he must secure drainage. A ditch is necessary for an outlet. Usually surface ditches may be used to advantage to carry away water.

Crops for Peat Soils. Where it is practical to grow them, truck crops are especially suited to peat soils. Potatoes do well if the soil contains mineral nutrients, especially potassium. As a whole, the small grains do not yield well on highly peaty soils. Grass crops, such as Reed Canary grass, are adapted to peat soils. This grass is often used to reclaim low-lying wet areas.

Following the growing of adapted crops, the addition of necessary fertilizers, and under proper management, it may be possible to grow any crop adapted to the section. In the northern states very successful seed crops of the clovers are produced on reclaimed peat soils.

SANDY SOILS

The term sandy soil is so broad that it is difficult to form a picture of a soil described as sandy. In the United States there are vast areas of soils of so sandy a nature that they are subject to wind erosion. These are the soils which offer special problems in their control. Soils which have a small quantity of sand mixed with organic matter to form a sandy loam are among our best soils and are not considered here.

Because sandy soils warm early in the spring they offer an opportunity to produce earlier-maturing crops. Vegetables and such crops as watermelons may be brought to market earlier when produced on a sandy soil. A better price is likely to be paid if the produce is superior to the average crop. The growing of vegetables offers one of the best ways to utilize sandy soils. In the Connecticut Valley, sandy soils are best for growing cigar-wrapper tobacco.

Problems with Sandy Soils. The sandy soils, as a class, are low in organic matter and are unable to retain sufficient water for best crop growth. Their utilization depends in part upon improving the organic content by incorporating plant residue with the sand. Whether it is practical to do so or not depends upon the coarseness of the sand and its location in reference to soils which are more productive. It must be remembered that these submarginal soils require added labor and expense to make them productive. The crops grown must compete with those produced on more fertile soils at a lower cost.

Fertilizers. As would be expected, sandy soils are likely to be deficient in plant food nutrients, as a result of leaching. Most of them benefit from the addition of commercial fertilizers, particularly phosphorus, potassium, and nitrogen. The nitrogen may be added through the growing of well-inoculated legume crops. As most sandy soils are deficient in calcium, it is necessary to apply lime to correct the acidity and permit the growing of such crops as alfalfa. The grower must consider carefully whether the expenditures for commercial fertilizers are justifiable or not. If he has a special market for vegetables or melons, he may reap a profit from the sandy farm. Barnyard manure is valuable, as it adds organic matter as well as needed fertility elements. The organic matter improves the water-holding capacity of the soil and aids in warding off damage by drouth.

Crops for Sandy Soils. The vegetable crops we have just said, are suited to the sandy soils. Of the grain crops, rye is the principal one. Probably it is grown on more sandy soil than any other grain. The small grains in general may be grown on sandy soils. Oats are the most likely to suffer from drouth. Corn is grown on sandy soils, provided they can be improved, so that they do not dry out too rapidly.

Potatoes will grow well on most sandy soils. Some growers use a straw mulch between the rows to keep down weeds and conserve moisture.

Prevention of Soil Blowing. Crops on sandy soils are frequently damaged by blowing. The shifting sand may cut off the young plants or it may pile up and cover the crop. By avoiding a level surface, it is possible to reduce wind erosion. On sands subject to serious wind action the crops may be planted in strips. Tall-growing plants reduce the wind movement and protect low-growing crops. Often the cultivated crop may be protected from blowing by cultivating every fourth or fifth row until it is possible to till the entire field. This cultivation must be repeated after every rain which levels the surface, until the plants are large enough to escape erosion damage.

MUCK SOILS

The muck soils are somewhat similar to peat, but are usually further advanced in decomposition. Most of them are richer in minerals than the peats. They are very loose and light in texture. As they are formed under wet conditions, drainage is essential to their reclamation.

Fertilizers. Most muck soils benefit from an application of fertilizer. Phosphorus and potassium frequently prove beneficial. The soil is also likely to be low in lime content. The treatment of these soils is much the same as that outlined for peat.

Crops. Much the same crops may be grown on muck soils as on peat areas. The mucks are further advanced in decomposition than the peats and usually are more easily cropped, if drainage is effected.

Suggestive Questions

1. How does a peat soil originate?
2. How does peat differ from muck?
3. Why is barnyard manure added to peat soils?
4. What grain crop is best suited to sandy soils?
5. Why are sandy soils suitable for vegetable crops?

Suggestive Activities

1. Fill one flowerpot with dry sand and another with heavy dry soil. Using a graduate cylinder, slowly add water to the sand until it drips out below. Add the same quantity to the heavy soil. Note the differences. How does the result of this experiment apply to farming?
2. If you live where peat or muck soils are found, dry a sample. Examine it carefully. What do you observe about its origin?
3. If either peat or muck soil is in your section, lay out test plots to determine the value of fertilizers in improving them.

CHAPTER XIX

PASTURES

American pastures, as a rule, are not as well developed as many of those found in European countries. There are several reasons for these differences. Probably the principal reason is the indifference of many farmers to the care the pasture should receive. Too many think of the pasture as a field where cultivated crops can not be grown and that they are consequently of little importance. To a great extent this attitude is responsible for the poor pastures so common in this country. In Europe the pasture may be the most valuable field on the farm. The return from its products may be the principal income of the farm family. Under these conditions the farmers have learned to value their pastures highly and to give them the care essential to their continued high production. While it is recognized that economic reasons may not justify the detailed care and management so prevalent in Europe; it is certain that the average pasture land would profit from greater care and attention than it is now receiving.

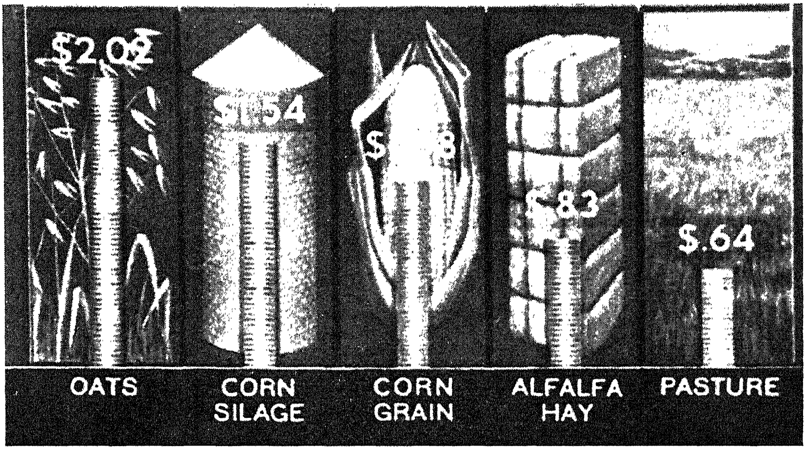


Figure 76. The relative cost of producing digestible nutrients by various crops.

In Chapter XII, *Agriculture II*, a fairly complete treatment of the different types of pastures was given. For review these are: (1) permanent pastures, (2) rotation pastures, (3) temporary pastures, (4) annual pastures, and (5) native pastures. In our present discussion we shall consider, for the most part, the permanent and the temporary pastures.

PERMANENT PASTURES

A pasture is regarded as permanent when it is undisturbed for several years. In other words, it is not a part of a regular rotation. Except for top dressing or reseeding, it receives no cultural treatment. Most of the permanent pastures do not receive treatment of any sort. Many are so located that the land can not be used for cultivated crops because of topography, stones, or other physical factors of interference.

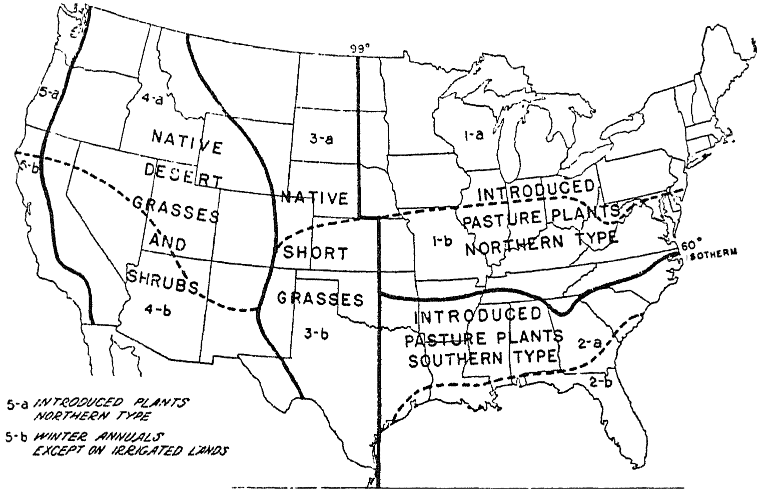

99°
5-a
4-a
NATIVE DESERT GRASSES AND SHRUBS
5-b
4-b
3-a
NATIVE SHORT GRASSES
3-b
1-a
INTRODUCED PASTURE PLANTS NORTHERN TYPE
1-b
60° ISOTHERM
INTRODUCED PASTURE PLANTS SOUTHERN TYPE
2-a
2-b
5-a INTRODUCED PLANTS NORTHERN TYPE
5-b WINTER ANNUALS EXCEPT ON IRRIGATED LANDS

Figure 77. Map showing the different sections of the United States in which the various pasture plants predominate.

Crops Used for Permanent Pasture. A rather complete list of pasture crops together with the regions of adaptability is given in Table XLI. By referring to Figure 77 the reader may determine pasture crops suited to his section.

Many of the plants, such as timothy and redtop, are used interchangeably for hay and pasture. Most of the hay plants lend themselves better to temporary than to permanent pastures. In the humid North, Kentucky bluegrass and white clover are

Name	*Climatic Adaptation*	*Degree of Palatability*	*Season of Grazing*	*Time and Rate of Seeding Per Acre*	*Soil Adaptation*	*Remarks*
Bahia grass (*Paspalum notatum*)	section 2b	high	early spring to late fall	early spring; 10 to 15 pounds	sandy loam to sand	seed expensive and of low germination
Bermuda grass (*Cynodon dactylon*)	region 2 and sections 3b and 4b	medium	late spring to early fall	early spring; 5 to 8 pounds	loams, clays and silts	propagated to a large extent vegetatively
Bromegrass or smooth brome (*Bromus inermis*)	western part of section 1a and sections 3a and 4a	high	very early spring to late fall	early spring or early fall; 15 to 20 pounds	practically any type	becomes sod-bound quickly
Canada bluegrass (*Poa compressa*)	region 1 and sections 3a and 4a	high	early spring to late fall	early spring or fall; 15 to 20 pounds	almost any type	succeeds on poor soils
Carpet grass (*Axonopus compressus*)	region 2	medium	spring to fall	early spring; 8 to 12 pounds	moist sandy or sandy loam	makes a very tight turf
Centipede grass (*Eremochloa ophiuroides*)	southern half of region 2	medium	spring to fall	early spring use sod or stolons no seed available	almost any type	makes a close turf and is very aggressive, crowding out weeds, legumes, and other grasses when once established
Crested wheatgrass (*Agropyron cristatum*)	sections 3a and 4a	high	very early spring to late fall	early spring; 12 to 15 pounds	almost any type	drought-resistant, easy to get a stand
Dallis grass (*Paspalum dilatatum*)	region 2 and sections 3b, 4b, and 5b where irrigated	high	early spring to late fall	early spring or fall; 8 to 12 pounds	any fairly productive soil	seed expensive and often of low germination, difficult to get a stand
Johnson grass (*Sorghum halepense*)	region 2 and sections 3b, also 4b where irrigated	high	spring to fall	early spring; 20 to 25 pounds	loams and clays	productiveness decreases rapidly when grazed, very difficult to eradicate
Kentucky bluegrass (*Poa pratensis*)	region 1 and section 5a, also 3a and 4a where moisture is plentiful	high	spring to late fall	early fall; 15 to 20 pounds	sandy loams to clay of high productivity	the leading pasture grass on good soils in the North
Meadow fescue (*Festuca elatior*)	region 1 and section 5a, also 4a where moisture is plentiful	high	early spring to late fall	early fall; 20 to 25 pounds	loams to heavy clays	valuable in section 5a, of limited value elsewhere, disappearing rather quickly, except on heavy moist clays
Meadow foxtail (*Alopecurus pratensis*)	sections 1a and 5a, also 4a at high altitudes	high	early spring to late fall	early fall; 20 to 25 pounds	moist sandy loams to clay	very useful in pasture mixtures on wet soils, especially in 5a

TABLE XLI—INFORMATION REGARDING GRASSES FOR PERMANENT PASTURES—(*Continued*)

Name	*Climatic Adaptation*	*Degree of Palatability*	*Season of Grazing*	*Time and Rate of Seeding Per Acre*	*Soil Adaptation*	*Remarks*
Orchard grass (*Dactylis glomerata*)	region 1, also sections 3a, 4a and 5a where moisture is plentiful	medium to high	early spring to fall	early fall or early spring; 20 to 25 pounds	any soil type except sand, if not too wet	inclined to grow in bunches unless seeded thickly
Para grass (*Panicum purpurascens*)	section 2b	high	spring to fall	early spring, no seed available	wet soils	propagated by planting pieces of stem or sod
Perennial ryegrass (*Lolium perenne*)	southern half of region 1 and in section 5a	high	early spring to late fall; winter grazing in section 2a to limited extent	very early fall (or spring in North); 20 to 25 pounds	sandy loams to clays of medium to good fertility	used but little in pasture, except in section 5a
Redtop (*Agrostis alba*)	regions 1, 2, and section 5a, also under irrigation and in mountain meadows, sections 3a and 4a	medium	early spring to late fall	early fall best; early spring fair; 10 to 12 pounds	grows on majority of soil types; prefers moist soils	redtop is of most value on poorly drained soils; too wet for other grasses
Reed canary grass (*Phalaris arundinacea*)	sections 1a and 5a, also 3a and 4a where moisture is plentiful	medium	spring to fall	very early spring; 8 to 12 pounds	loams to heavy clays	seed very expensive; very good for wet lands, will endure submergence
Rescue grass (*Bromus catharticus*)	region 2 and where moisture is sufficient in sections 3b and 4b	medium	fall to spring (winter pasture)	early fall; 20 to 25 pounds	sandy loam to clay loam	an annual used in some localities for winter and spring grazing
Rhodes grass (*Chloris gayana*)	section 2b; also southern parts of 3b and 4b	medium	spring to fall	spring; 10 to 12 pounds	loams to clays	found most useful in the dry sections of southern Texas where other grasses fail
Slender wheatgrass (*Agropyron panciflorum*)	northern parts of sections 3a and 4a	high	early spring to late fall	early spring; 15 pounds	practically any type, except sand	better for hay than pasture, inclined to be stemmy
Tall oatgrass (*Arrhenatherum elatius*)	sections 1b and 5a	medium	early spring to late fall	early fall; 20 to 25 pounds	practically any type, except sand	better in hay mixtures than for pasture, stemmy, used most for pasture in section 5a
Timothy (*Phleum pratense*)	region 1 and section 5a, also 3a where moisture is sufficient	high	early spring to late fall	early fall (or early spring); 12 to 15 pounds	practically any type, except sand	comes quickly and furnishes much pasturage at first, but is not permanent

For purposes of convenience in study, the legume pasture plants are listed in a separate Table.

TABLE XLI UM FOR P ANENT PASTU *Co y o. U.S.D.A*

Name	*Climatic Adaptation*	*Degree of Palatability*	*Season for Grazing*	*Time and Rate of Seeding Per Acre*	*Soil Adaptation*	*Remarks*
Alfalfa (*Medicago sativa*)	all regions where moisture is sufficient, but only locally in region 2	very high	spring to early fall. Winter grazing in Southwest, where irrigated	depending on location—consult State Exp. Station	practically any fertile soil type not wet nor acid	good pasture, but danger of bloat
Alsike clover (*Trifolium hybridum*)	chiefly region 1 and section 5a. In sections 3a and 4a if moisture is sufficient. Winter crop region 2	very high	early spring and fall	early spring; 8 to 10 pounds	practically any soil type, except sands. Will stand slight acidity	especially suited for wet land
Red clover (*Trifolium pratense*)	chief region 1 and section 5a. In sections 3a and 4a if moisture is sufficient. Winter crop region 2	very high	early spring to fall	early spring; 10 to 15 pounds	practically any well-drained soil if not acid	use locally adapted seed
Mammoth red clover (*Trifolium pratense* var.)	region 1, chiefly section 1a	high	early spring to fall	early spring; 10 to 12 pounds	practically any well-drained soil, not more than slightly acid	will endure slightly more soil acidity than common red
White clover (*Trifolium repens*)	all regions where moisture is sufficient	very high	early spring and fall	very early spring; 5 to 10 pounds	practically any soil type	everywhere in the North, in region 2, winter and spring crop
Ladino clover (*Trifolium repens* var.)	sections 4a, 5a, and 5b	very high	spring to fall	early spring; 5 to 10 pounds	practically any well-drained, well-watered soil	very productive but injured by heavy continuous grazing, danger of bloat
Least hop clover (*Trifolium dubium*)	sections 2a and 5a and parts of 1b	high	spring	late summer; 4 to 5 pounds	good soil	annual, disappears in June, volunteers
Low hop clover (*Trifolium procumbens*)	section 2a and southern part of section 1b	high	spring	late summer; 4 to 5 pounds	practically any well-drained soil	annual, usually disappears in June but volunteers
Sweet clover (*Melilotus alba and M. officinalis*)	regions 1, 2, and 3, also section 4a where moisture is sufficient	medium	very early spring (2nd year) to late fall (1st year)	winter and very early spring; 15 to 20 pounds	any well-drained non-acid soil	nutritious pasture, but its success often requires applications of lime
California bur clover (*Medicago hispida*)	sections 3b, 4b, and 5b, if sufficient moisture, also eastern Texas and Oklahoma	high	fall to spring	late summer; 15 to 20 pounds hulled seed	well-drained soils of practically any type	a winter annual, volunteers
Southern bur clover (*Medicago arabica*)	region 2 and section 3b	high	fall to spring	late summer; 10 to 15 pounds hulled seed	well-drained soil	winter annual, but reseeds
Common lespedeza (*Lespedeza striata*)	region 2 and section 1b	high	early summer to fall	early spring; 20 to 25 pounds	well-drained soil	annual, but is usually permanent in pastures because of volunteer seeding

leading permanent pasture varieties. In the South, Bermuda and carpet grass are common. In the Great Plains area the bunch grasses, including the gramas and buffalo grass, are important. Each section has its group of plants especially adapted to the existing conditions. While most of our valuable pasture plants are perennial, some important varieties are annuals. The common lespedezas, for example, are very important. Because of their habit of reseeding themselves they may serve to provide a continuous growth and thus serve in a permanent pasture.

Establishing a Permanent Pasture. In some sections it is desirable to establish a permanent pasture. Many worn-out meadows may be utilized in this manner. Permanent pastures are started in much the same method followed in establishing a meadow. As the seeds are small, it is imperative that the best seed-bed conditions be provided, that is, a firm well-prepared seed bed.

The fertility of the soil should support a meadow crop, such as alfalfa. If the soil is acid, lime may be worked into the soil before seeding. Often phosphorus and potassium supplies are low. If so, these are applied at the time of seeding the crop.

It is important that crops suited to the section be chosen. These may be determined by reference to the last two preceding Tables and the figure which illustrates the pasture regions. Nearly always it is desirable to seed a combination of crops, so that a quick turf may be established. The student should refer to the mixtures given in Chapter XII, *Agriculture II.*

Pasture Renovation. Many pastures are in need of renovation. In their present form they are little more than exercise plots for the livestock. Some of the things to do in renovation are:

1. Test the soil to determine its fertilizer needs, if any. Possibly lime must be added. Not infrequently the soils are low in phosphorus.

2. Apply fertilizers to the surface of the soil as a top dressing early in the spring before growth has started. Barnyard manure or commercial fertilizers may be used to advantage.

3. As soon as dry enough disk the surface thoroughly, leveling it afterwards with a smoothing harrow.

4. Seed a suitable mixture just as early as possible. It should be spread over the surface and harrowed lightly. If the pasture is likely to erode, seed a companion crop, such as oats or barley, at a light rate. Pasture the grain crop before it heads to prevent its smothering the new seeding.

5. Use a cultipacker or roller to firm the seed bed after planting. Rapid germination will be encouraged and a new seeding given a better chance to get started ahead of the weeds.

6. It is imperative, if a successful job is to be done, to protect the newly-seeded area against livestock until a sod is established.

Maintaining a Permanent Pasture. The job is not complete after one has established a new permanent pasture or has renovated an old one. Most pastures in need of renovation have been depleted because they were abused. Some of the things to be done to maintain the pasture are given below.

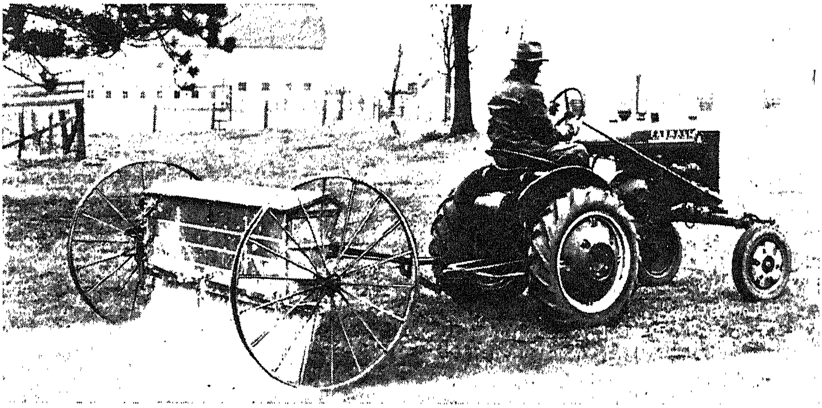


Figure 78. Applying fertilizer as a top dressing on a permanent pasture.

1. Do not turn livestock into the pasture too early in the spring. Early pasturing probably destroys more pastures than any other single act. The trampling of the animals on the soft surface tends to destroy the sod. It is necessary also that the plants be given an opportunity to recover from the winter by establishing a strong root and top growth.

2. Do not place too many animals in the pasture. The pasture should be watched to prevent overgrazing. After all, it is necessary to leave some growth, if the plants are to live. If overgrazed, destruction is certain. The use of supplemental temporary pastures is desirable to avoid overgrazing.

3. Reseed bare spots before the frost is out of the ground. This seed should be worked into the surface.

4. Apply barnyard manure to the pastures at least once every four or five years.

5. Use commercial fertilizers to supplement the manure.

6. Cut all weeds and brush regularly to prevent their estab-

lishment and seed formation. Weed encroachment is usually an indication of unfavorable conditions for the desired pasture plants.

Only by consistent care and management such as is usually given a cultivated crop can one hope to maintain a permanent pasture in a state of high productivity.

TEMPORARY PASTURES

The temporary pasture is usually one that fits into the rotation. It may be a hay crop utilized for pasture. The winterkilling of the meadow may result in a shortage of feed. The crop seeded may be of an emergency type to replace the lost forage. There are many variations in the use of the temporary pastures.

Crops for Temporary Pastures. In our consideration of forages it was indicated that most of these might serve as pasture crops either as a regular procedure or as an emergency proposition. It is not necessary to repeat a discussion of each of these crops. Attention will be called to those of greatest importance.

Of the perennials used for temporary pasture, alfalfa and timothy are probably the most important. Thus, while the crop is seeded for hay production, it is not unusual to pasture it a part of the time.

The biennial and annual crops are very important. The various clovers, including sweet clover and medium red, are very valuable. Probably sweet clover is used far more for temporary pasture than the other crops. Crimson clover is important along the Atlantic seaboard. The lespedezas have been mentioned as important pasture plants. Sudan grass and the millets provide quick-growing pasturage within a short time. Sudan grass is very widely used as a temporary pasture crop.

The cereal crops provide emergency grazing. Many farmers regularly utilize rye in the fall and spring for pasture. The animals are removed soon enough to permit the plants to resume growth and mature a grain crop. Winter wheat may be used in the same manner. The spring-sown cereals are seeded for the purpose of furnishing nutritious forage.

Rape, a member of the mustard family, is sown in the cooler sections to provide succulent temporary pasture for hogs and sheep.

Growing Temporary Pastures. Most of the crops discussed for temporary pasture have been considered under the heading of forages. These discussions apply here as well. Many of them are seeded in emergency. During the drouth years many farmers found Sudan grass to be a life-saver in providing needed forage. It should be remembered that temporary pastures remove plant food from the soil the same way as other crops do. For this reason they respond to fertilization in much the same manner as a grain crop.

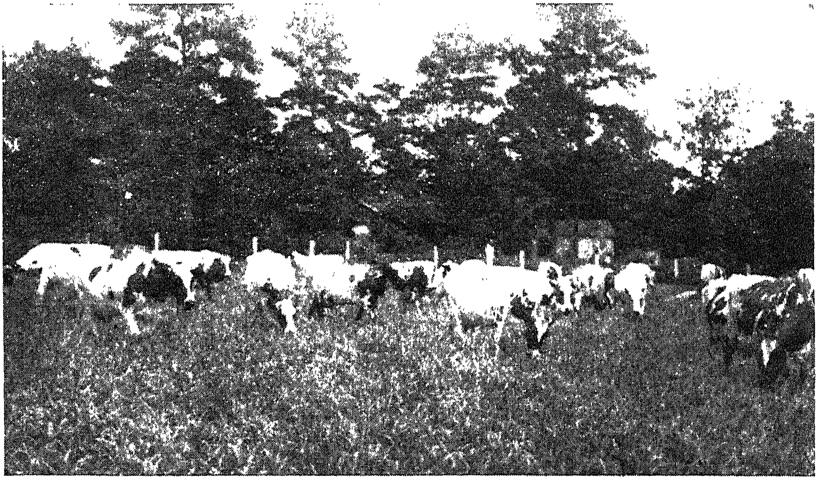


Figure 79. Cattle grazing a temporary pasture of Sudan grass.

Why Do Farmers Use Temporary Pastures? The average farmer using temporary pastures regularly believes that, by making the pasture crop a part of his rotation scheme, he can secure greater returns from the land, maintain a higher degree of fertility, and have better control of weedy plants. It is probable also that he is better able to provide a uniform production. The temporary pastures are likely to yield more consistently year after year than the permanent types. If the permanent pasture were to receive as good care, this difference probably would not exist. If a permanent pasture can be made to yield as well as a temporary, it has decided advantages. There is the saving of labor in seeding and the cost of the seed. The use of temporary pasture makes possible crop rotation and may result in better yields of the cash crops produced for market. These problems must be considered in making the final decision. It is probable that, in general, the farmer with productive, tillable soil will tend to use the temporary pasture in rotation with his other crops. The growing of permanent pasture on the poorer, untillable land is best under many conditions, and should be satisfactory if good management is followed to insure greatest returns.

Suggestive Questions

1. What are the best pasture plants in your community?
2. In your opinion why are so many pastures unprofitable?
3. Under what conditions would you use a meadow for pasture?
4. What pasture grasses will succeed on low, wet soils?
5. Why do mixtures of grasses and legumes provide superior pasture as compared with pastures of but a single species?

Suggestive Activities

1. Map the pastures of your community, indicating permanent and temporary areas.
2. Make a collection of weedy plants infesting local pastures. Plan a program for their control.
3. Secure samples of common pasture grasses and make up desirable mixtures suited to your area.

CHAPTER XX

CARE AND MANAGEMENT OF THE DAIRY HERD

In *Agriculture II* dairying was presented as a complex enterprise requiring careful attention to adjustment with the other farm enterprises. It has also been emphasized that profitable dairying requires cows that have the inherited capacities to produce economically and then that proper feeding and care must be practiced. It shall be the purpose here to consider the proper operation of the dairy enterprise, assuming that this enterprise has been adjusted in relation to the other farm enterprises.

The first requirement in the efficient operation of a dairy enterprise is to furnish suitable physical equipment for the comfort of the cows and to make the work about the dairy easier and more pleasant. Next the right kinds and the correct amounts of feed must be provided and lastly the herd must be properly cared for in all respects.

THE PHYSICAL EQUIPMENT

While most dairy farms have barns, sheds, and yards which constitute the essential parts of the physical equipment, such equipment in many cases is not adequate or needs some change or alteration. That one may be better equipped to make changes, alterations, or even completely remodel or rebuild the physical plant on a dairy farm, the fundamentals involved in satisfactory buildings, yards, and equipment will be considered.

Buildings. The whole physical plant centers around the dairy barn. Other essential structures are dependent upon the dairy barn for their need, location, and general structure. Housing facilities must be provided for milking cows, calves, young stock, and the herd sire. If the dairy barn provides for all these, special buildings are not necessary. Likewise, under certain conditions, the milk house may be incorporated in the dairy barn. Under other conditions special buildings are provided for each of the aforementioned classes of dairy cattle and for the handling of the milk. First, the fundamental requirements of a satisfactory barn will be considered. Next we will treat housing for calves, young stock, and the herd sire, when provisions for these groups are not made in the dairy barn. These topics will be followed by a discussion of barnyards and the milk house.

The Dairy Barn. In altering or remodeling a dairy barn the object should be to make it as near the ideal as possible. Consideration of the essentials for a satisfactory dairy barn will serve equally well whether a new structure is contemplated or an old one is to be altered or remodeled. These essential considerations are noted under the following heads:

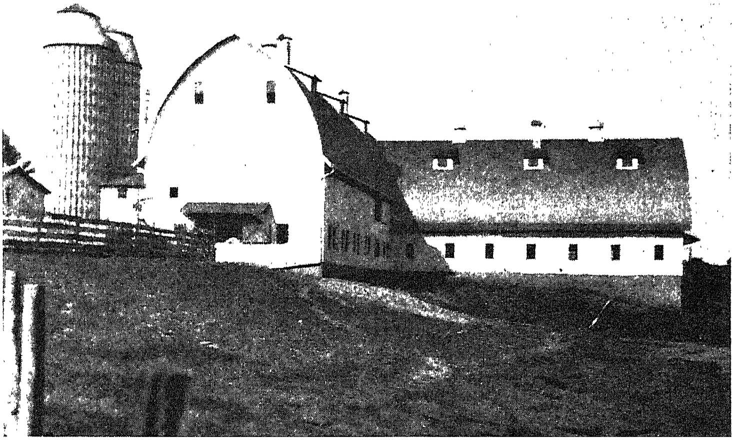


Figure 80. A modern dairy barn L-shaped.

1. Location
2. Type
3. Size
4. Material of which constructed
5. Ventilation
6. Interior arrangement
7. Equipment
8. Attractiveness
9. Cost

Location of the Dairy Barn. To find the ideal location for the dairy barn is in most cases very difficult. It usually becomes necessary to select a location that will satisfy as many as possible of the desired requirements. The first requirement is that it be located in a place offering good draining facilities. The site should also be where adequate yard conveniences may be provided. It should be from 150 to 200 feet from the house, in order to reduce the odors emanating from the barn. It is also obvious that it should be located convenient to the pasture. As much heavy hauling to and from the barn of such material as feed and manure is required at all times, a location near a road is preferable. As shade for the yard is very desirable, if at all possible, the barn should be located near a grove.

The next question to settle in the location of a barn is the direction that the long axis should take. As there are good arguments for an east and west as well as a north and south direction of the long axis of the barn, this is not a question of first importance. When the barn is located in a north and south direction, rays from both the morning and afternoon sun may enter and during the day all parts of the barn may be exposed to the direct rays of the sun. When the barn is located in the east and west direction the stronger rays of the midday sun will sweep most of the interior. Another good argument for this direction is that more protection against the cold north wind is afforded a yard on the south side and a yard on the north side is afforded more protection from the hot summer sun.

Type of Barn. There are many different types of dairy barns, each having its advantages and disadvantages. On the basis of the general structural features, barns may be classified as follows:

1. One-story barns
2. Lean-to barns
3. Two-story barns
4. Basement barns
5. Round barns
6. Resting sheds
7. General-purpose barns
8. Special milking barns

One-story Barns. The one-story barn is what the term implies. It consists of walls of the various construction materials, a roof, and may or may not have a ceiling. It has no storage facilities for feed except insofar as provisions may be made for them in some section of the barn. Most generally facilities for feed storage are provided in other buildings adjacent to the barn. This type of barn is found in all sections of the country and is mostly used as any other barn.

The advantage claimed for the one-story barn is that it makes for cleaner milk production. As no feed is stored above, it is claimed that less dust and dirt will fall into the barn. The chief disadvantages are that the handling of feed becomes more difficult, as feedstuffs are usually stored outside the barn and must be carried some distance; the building costs become greater because of the added expense of providing separate buildings for feed storage; in cold climates it becomes more difficult to keep such a barn warm because of the lack of the insulating effect of the hay stored above in a two-story barn; and in hot weather one-story barns become very warm because there is no large air space above to act as insulation.

Two-story Barns. The two-story barn is the most common barn and, as a rule, the most practical. With few exceptions, the first floor is used to house the cattle and the second story is used for hay and feed storage. The most common shape is rectangular, although two-story barns may be T-shaped, L-shaped or U-shaped. Sometimes one part of the above mentioned forms may be but one story in height and be used for feed grinding and mixing or be equipped with special box stalls and used as a maternity or isolation ward.

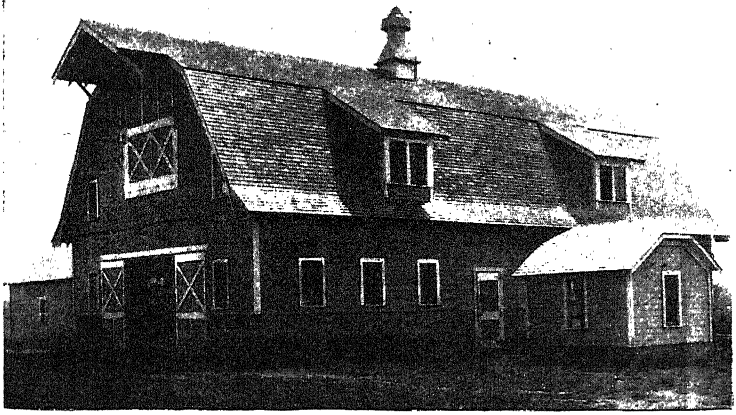


Figure 81. A common two-story type of barn. Note the milk house separated from the barn.

The chief advantages of the two-story barn over the one-story barn are: lower cost in buildings, less labor involved in the handling of the feed, and better insulation against both heat and cold, due to the large air space of the second story and the stored hay. The chief disadvantage is that dust and dirt are apt to fall through the ceiling from the stored feed. This difficulty, however, may be overcome to a large extent by the construction of a tight ceiling.

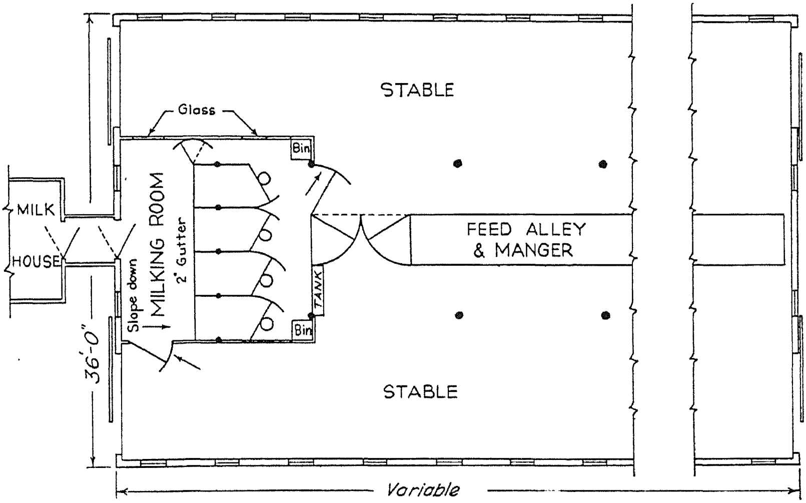
The Lean-to Barn. The typical lean-to barn is a one-story structure built against a two-story barn. Its chief advantage is that it may be constructed at low cost as only three walls are needed—one side, and two end walls. If built on the south side, it has the advantage of protection against cold north winds in the more severe climates. It has the same general disadvantages of the one-story barn with an additional problem of adequate lighting.

The Basement Barn. The basement barn may be two or three stories in height, with one or more of the walls of the first floor below the surface of the ground. It is most common in hilly regions, where it is constructed on the side of a hill and where the second floor is on the upper ground level and into which it is usually possible to drive. Another advantage of the basement barn is that it is warm in the winter and cool in the summer. The chief objection to the basement barn is that it is difficult to keep in a clean, sanitary condition. Because one or more of the walls are below the level of the ground, basement barns can not be adequately lighted nor will all the interior be exposed to the sun's rays that are very essential for their drying and sterilizing effects. For these reasons basement barns are usually damp and musty.

Round Barns. The round barn has been popular in but few communities, notwithstanding the fact that rectangular barns cost more than a third again as much for the same floor space. The stalls are usually arranged in a circle facing inward with the silo and other feeding arrangements in the center of the barn. The barn is always a two-story structure with hay and other feed storage facilities on the second floor. No other barn can afford the convenience in feeding that the round barn does, but other objections seem to outweigh this advantage. The chief objections are that it is difficult to fill the silo located in the center of the barn, because of its shape it is difficult to mow the hay, and that sunlight can not reach the north part of the barn.

Resting Sheds. By resting shed is meant a structure where cows run loose. It may be either a one or two-story structure. Generally feed racks are provided in the shed where hay and silage are fed. The hay, in case of a two-story barn, is pushed down from the second floor directly into the hayrack. The hay is usually kept before the cows all the time and the racks may have hay capacity to last for several days. A milking barn with several stalls is usually provided either within the resting shed, as a lean-to or as a separate building. At milking time the cows are removed to the milking barn and fed their concentrates while being milked.

Management of the resting shed varies widely. As a rule, a minimum floor space of 45 square feet for small cows and 65 square feet for large cows is required. This space is about one fourth more than is required when cows are kept in stalls and stanchions. The shed should be cleaned at infrequent intervals—sometimes but once a year. The shed is kept dry by generous allowance of bedding usually requiring half again as much as when cows are kept in stalls and stanchions.



BARN LENGTH	*NUMBER OF COWS*	
	HOLSTEIN	*JERSEY*
48	*20*	*24*
64	*32*	*40*
80	*44*	*56*
96	*58*	*72*

Figure 82. One plan for a barn where cows run loose. The milking room is within the barn, an advantage in cold weather. In other plans the milking room may be a lean-to on one side of the barn.

Many advantages are claimed for the system. Among the more important are:

1. Because no floors, stalls, stanchions, drinking cups or other usual barn equipment are needed, the cost of barn construction is greatly reduced.

2. Much less labor is needed in caring for the cows. The work in feeding is reduced, and daily cleaning of the barn is spared.

3. The cows have more freedom and have a more comfortable and warmer bed than when confined to stalls and stanchions.

4. The fertility of the manure is conserved, as it is always well packed, minimizes fermentation, and, since it is in the barn, it is not exposed to the leaching of the elements.

5. When the shed is well bedded, the cows keep cleaner than when in stalls and stanchions.

6. It is claimed by the proponents of the system that cows kept in resting sheds are less subject to udder injuries and mastitis.

General-Purpose Barns. By general-purpose barns is meant barns where horses as well as all classes of cattle are kept. To keep horses in the same barn with milking cows is not regarded as good practice. Standard milk ordinances forbid such a practice. In most places horses may be kept in the barn with milking cows when a partition intervenes between the horses and the cattle. The keeping of calves, young stock, and the herd sire in the same barn with the milk cows is practiced generally and is usually the most economical way of caring for them.

Special Milking Barns. For high-grade market milk production and where cows are kept in resting sheds, special barns are frequently provided for milking. These barns may have but a few stalls. In some cases they are equipped as milking parlors and are kept scrupulously clean.

Size of Barns. The correct width and height of a barn vary but little. Length varies with the size of the herd that is to be accommodated. In colder climates it is well to confine the height from the floor to the ceiling to between 8 and 9 feet. Less than 8 feet will not permit the necessary air space which should be about 500 cubic feet for each cow. More than 9 feet to the ceiling makes it difficult to keep the barn warm, except in warm climates.

For widths of barns the rectangular barn providing two rows of stalls is the most common and will illustrate the principles involved. While these barns vary from 30 feet to more than 38 feet in width, the best width has been found to be 36 feet, when cows face out, and 34 feet, when the cows face in. When the cows face in, a barn 34 feet wide on the average will permit a feed alley 4 feet 3 inches wide and each of the two alleys behind the cows can be 5 feet 3 inches, the minimum advised. While either of these two alleys may be narrower than these dimensions, the convenience in working about the dairy barn will be reduced. Less than 5 feet and 3 inches behind the cows causes splattering of manure upon the walls.

When cows face out, the 36-foot width is advised, for such width is the minimum that will permit an 8-foot center alley and still have 4 feet 3 inches for each of the two feed alleys. An 8-foot center alley is the least that permits driving through the barn.

Construction Materials for Barns. Space will not permit more than the most superficial treatment of materials suitable for barn construction. Anywhere near adequate consideration of this subject would require a volume in itself. Wood, brick, tile, stone, concrete, metal, and various composition materials have been used for barn construction.

Wood is the most commonly used and is an excellent insulating material. Tightly-matched inch boards on both the inside and the outside of the studs are sufficient for warmth of barns in the coldest climates. Another advantage of wood, particularly on the inside of barns, is that it minimizes the condensation on the walls, which is troublesome in cold weather. The disadvantage of wood is that it is subject to decay. This objection, however, may be minimized by painting and keeping the barn dry through proper ventilation.

Brick, tile, concrete, stone, and metal are more durable than wood, but are usually more expensive, and, unless adequate dead air spaces are provided in the wall, condensation on the inside will be experienced in cold weather and a damp, musty condition will result.

Ventilation of Barns. There are three reasons why barns should be ventilated. The first is to supply the cows with fresh air; the second is to get rid of the excess moisture; and the third is to avoid the foul odors. The average cow breathes about 116 cubic feet of air per hour. The exhaled air contains about 5.5 per cent of carbon dioxide, which, if permitted to accumulate, will ultimately cause asphyxiation. The exhaled air is also laden with moisture. From 12 to 18 pounds of water is exhaled daily by the average cow. Unless removed from the barn during cold weather, this water will condense upon the walls and ceiling of the barn. Odors from the exhaled air and the excreta are offensive and will contaminate the milk unless they are removed.

Experiments have shown that, to maintain a satisfactory air condition in a closed barn, 3,600 cubic feet of fresh air must be taken in per cow for each 24 hours. A barn may be ventilated by either the use of a motored fan or by proper inlets and outlets by using natural forces. The motor-driven fan is, of course, the simplest and, in most cases, where electricity is available, it is the cheapest and the most satisfactory. A suitable number of fans is set in the wall near the ceiling to force out approximately 3,600 cubic feet of air per cow per day.

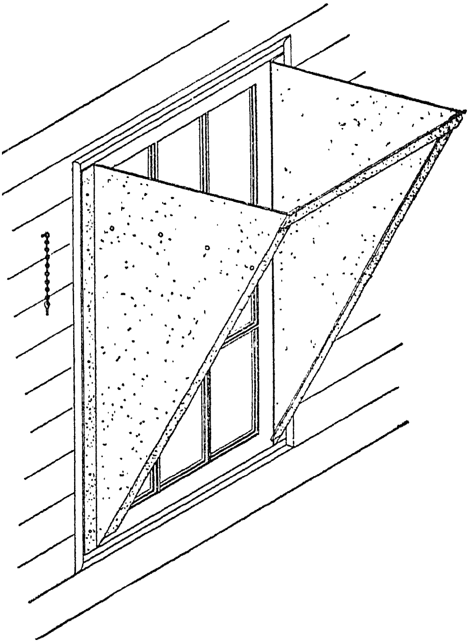


Figure 83. One way of providing ventilation at low cost is to hinge the window sash at the bottom, so that they may tilt in. Metal shields on the sides prevent the incoming air from going anywhere but over the top of the sash.

When one must depend on natural forces, the simplest way is merely to open the windows. While this method requires constant adjustments, depending upon temperature and the velocity and direction of the wind, it is cheap and will work, if given proper attention. To avoid direct drafts, the windows should be hinged at the bottom and sheet iron shields fastened on the inside of the frames, so that, when the window is tilted in, the incoming air goes over the top of the tilted-in window. In this way the incoming currents of air strike the ceiling first and become warmed before striking the cattle. The essential features of the tilt-in window are shown in Figure 83.

More elaborate ventilation systems requiring inlet and outlet flues require too much space for adequate description here. The two best known of these systems are the King and the Rutherford. These systems depend upon the principle that warm air is lighter than cold air and will, therefore, rise. The outlet flues in both systems are insulated and rise through the haymow to the highest point of the barn. The long column of warm air rises to create a lowered pressure within the barn and fresh outside air rushes in through properly located intake flues. The chief difficulty with these systems is that in cold, windy weather they are likely to work too well and overventilate the barn and reduce the temperature too much. On mild, still days the systems may not work.

Interior Arrangement of the Barn. The three main objectives in arranging the interior of a barn are: To provide for the maximum comfort of the cattle, to utilize the space most economically, and to provide for the greatest convenience in doing the necessary barn work. The main questions arising in this connection are: Shall cows be faced in or out? How much window space? What kind of stalls? What kind of manger? What type of floor? And what about labor-saving equipment?

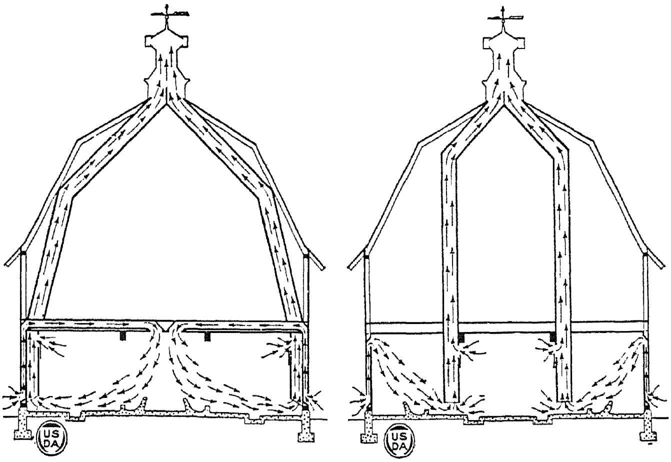


Figure 84. The principle of the hinge ventilating system. A—When cows face inward. B—When cows face outward.

What Way to Face the Cows. There are proponents for both ways of facing cows in a barn and advantages for each. When cows face in, feeding is made easier. When cows face out, milking is made more convenient, the herd shows off to better advantage, cleaning the barn is easier, and the cows may be let in and out of one door. When cows face out, there is also a more economical utilization of the space, as one alley behind the cows serves for both rows and this alley should be wider than the feeding alley.

Window Space. It is very desirable that the direct rays of the sun should strike every part of the barn. Four square feet of glass should be provided for each cow or one square foot of glass for each 25 square feet of floor space. Windows containing

12 lights of 8x12 inch, spaced one for each 7 feet on each side of a 36-feet wide barn, will supply the right amount of light.

Stalls and Stanchions. In furnishing a barn with stalls there are three major problems: whether to face the cows in or out, the size of the stall, and the kind of stall and stanchion. The pros and cons for the way to face cows have been discussed.

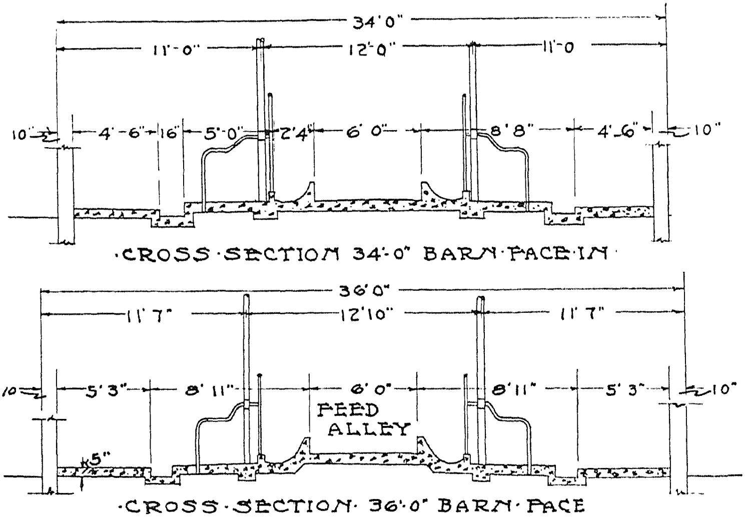


Figure 85. Section showing distribution of space for barns 34 and 36 feet wide when cows face in.

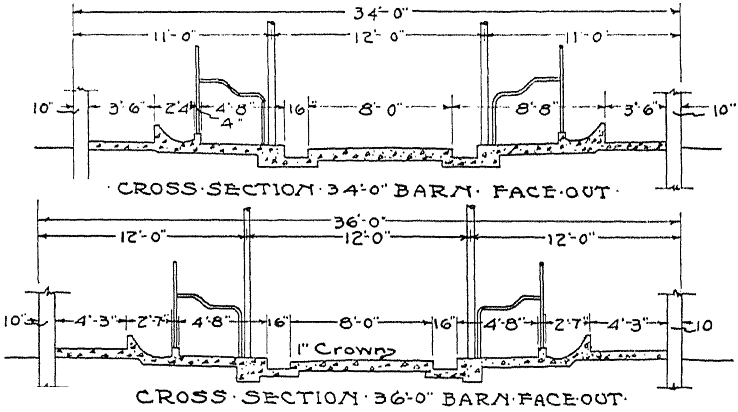


Figure 86. Section showing distribution of space for barns 34 and 36 feet wide when cows face out.

The proper size for the stall is a very important consideration. If the stalls are too narrow, the cows become too crowded and milking and working around them become more difficult. When too crowded, more injury is likely to occur to the udders by cows stepping upon one another. The length should be properly adjusted to the length of the cow. If the stall is too long, the cows become unduly soiled; if too short, the cows will stand in the gutter, be uncomfortable, and are also likely to injure their teats and udder by stepping upon them when getting out of the gutter. The proper lengths and widths of stalls for the different breeds are given in Table XLIII.

TABLE XLIII—Proper Lengths and Widths of Stalls for Different Dairy Breeds

Breed	*Length of Stall*						*Width of Stall*					
		feet	inches		feet	inches		feet	inches		feet	inches
Ayrshire	From	4	6	To	4	10	From	3	5	To	4	1
Guernseys	"	4	6	"	4	10	"	3	5	"	4	0
Holstein and Brown Swiss	"	4	10	"	6	8	"	3	10	"	4	2
Jerseys	"	4	5	"	4	8	"	3	2	"	3	8
Shorthorns	"	4	8	"	5	4	"	3	6	"	4	0

The type of stalls and stanchions used will depend upon the material available and the amount of money that can be spent. Homemade wooden stalls and stanchions can be constructed and are just as comfortable and less expensive than those made of iron. The many different makes of stalls and stanchions that are on the market and made of metal are more durable, are neater in appearance, and are more easily kept clean.

Box Stalls. Every barn should be equipped with at least one box stall to be used for a maternity pen or for injured or ailing animals. A box stall should be not less than nine feet square and should be located preferably in one corner of the barn. In the resting shed, or the pen-type of barn, box stalls can be provided by merely fencing off a suitable area in one corner of the barn.

Calf Pens. The essentials for satisfactory calf pens are given in *Agriculture II*. These pens should preferably be located on the south side of the barn where they may be exposed to the greatest amount of sunlight.

Stall Floors. One of the big problems in barn construction is that of getting a satisfactory stall floor that is not too expensive. The prime requisites for a satisfactory stall floor are: it must not be slippery when wet, it must be easy to keep clean, it must not be cold, and it must be durable. As yet no material has been found that can be regarded ideal for stall floors. Concrete is durable, easy to keep clean, and may be roughened to prevent slipperiness; but it is cold. Wood is warm, but is slippery, difficult to keep clean, and is not durable. Creosoted wood blocks are a great improvement over wood planks, but are expensive. Cork is an ideal floor for a while, but is expensive and has a tendency to depress from the weight of the cow's feet. Several plastic compounds are on the market for which more time is required before they can be properly evaluated.

Barn Floors. The primary requisites for a barn floor are that it must be easy to keep clean and it must be durable and not slippery. Concrete is the most common and, in general, the most satisfactory barn floor. If properly laid, concrete floors are free from cracks and can be easily washed. In the alleyways the last coat of concrete should be roughened with a coarse brush in order to prevent it from becoming slippery. Slipperiness on an already established smooth concrete floor may be partially prevented by application of ground limestone.

Equipment for Cleaning. One of the most disliked chores about the barn is that of cleaning out the litter. The easiest and most economical way of cleaning a barn is to load the litter directly on the manure spreader driven into the barn. When the litter is thus hauled directly out on the land only one handling is needed. The next best method (and one to be advised only if the barn does not permit driving through) is the use of a litter carrier and dumping the litter directly into a manure spreader.

Feeding Equipment. Much labor can be saved by first locating the source of the feeds in the most convenient place, and, secondly, by providing conveyors for the silage and the concentrate. As hay is almost invariably carried to the cows by means of a fork and many trips must be made at each feeding, the hay chute should be located as near the center of the barn as possible. For silage and concentrate feeding, carts should be provided to avoid much of the hard labor in carting these in baskets, as is frequently done.

Provision for Storing and Handling Concentrates. The labor involved in grinding and mixing the concentrates can be greatly reduced in most cases by a little planning. One of the most expedient ways of handling the concentrates is to provide a room on the second floor where the grains may be stored, ground, and mixed. For large herds a mechanical mixer is to be advised. For others a floor space should be provided where the feeds to be mixed may be shoveled back and forth until thoroughly mixed.

Another labor-saving device is a hopper with a chute going down into the barn, so that the concentrates may be drawn in the barn as needed. There must be as many hoppers with chutes as there are different feeds.

Attractiveness of the Barn. It is very desirable that the barn should be as attractive as possible, that is consistent with cost. It may be made more attractive by the use of appropriate paint, and by improving the adjacent yards, particularly the fences, and by landscaping. These need not be very expensive and will be found to be very worth-while projects. An attractive farmstead adds much to the joy of ownership.

Cost of Barns. One of the most important considerations in building or remodeling a barn is the cost involved. Too much money invested in a barn saddles the dairy enterprise with an overhead that may make profit impossible. Assuming that the barn cost is $100.00 per milking cow and that money bears 5 per cent interest, that there is an annual depreciation of 3 per cent, these two items alone would carry an annual charge per cow of $8.00. In addition there are insurance, taxes, and repair charges that are more or less proportional to the cost of the structure. It is, therefore, obvious that the cost of the barn should be kept to the lowest possible level that will provide the necessary comfort to the cows and the necessary convenience for the workers. One of the reasons for the growing popularity of the resting shed is that the building costs are lower than for the conventional barns. As building materials vary greatly in cost in different parts of the country, the costs of suitable barns vary greatly. Satisfactory resting sheds with accompanying milking stalls have been built for less than $30.00 per cow. In most places standard dairy barns, equipped with stalls and stanchions and the necessary provisions for feed storage, cost from $75 to $100 per cow.

The Barnyards. Adequate yards adjacent to the barn are essential for proper management of a dairy herd. Such yards are needed for retaining the cows before they are taken into the barn and again after they are let out. During the winter, yards are needed as a place for exercising the young stock and on warm days for the milking cows as well. The number and sizes of the yards needed depend upon the size of the herd. As a rule, two yards will be needed in addition to the bull yard, in order that the herd may be segregated into at least two separate groups. If horses are kept in the cow barn, another yard should be provided for them, as cattle and horses should be kept separate.

One of the prime requisites of a good cow yard is that it be well drained. On poorly drained soil it usually becomes necessary to place a slab of concrete outside the barn door to avoid the formation of mud that would otherwise be formed.

Bedding. Bedding is used to keep cows clean and to make them comfortable. The requirements of a good bedding are: it must have high moisture-absorbing powers, it must be clean, that is, free from dust and musty odors, it must be dry, and it should have reasonable clinging powers, that is, the property to stay in place in the stall.

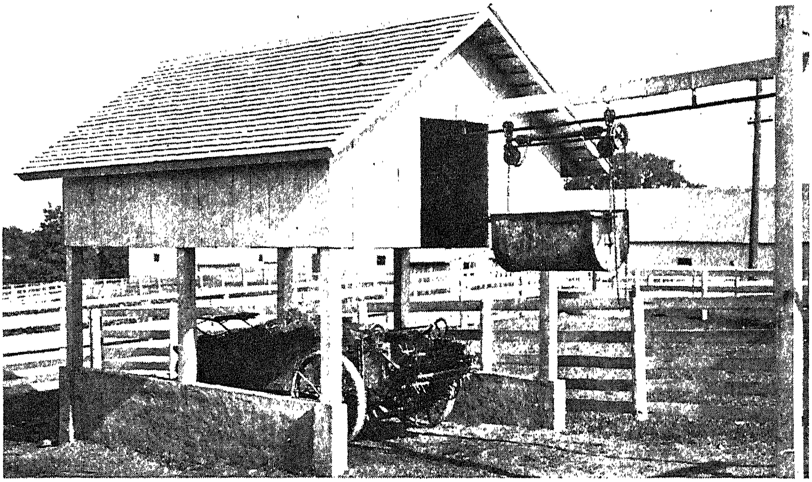


Figure 87. Adequate well-drained and well-fenced yard facilities for the handling of the litter are desirable for the dairy.

Wheat and oat straw are the most commonly-used beddings. Of these oat straw is a little superior to wheat straw, absorbing 250 and 210 pounds of water respectively per 100 pounds of straw. Wood shavings are popular with many because of their refreshing odor. Shavings do not cling to the stall floor as well as the cereal straws and are somewhat poorer in moisture-absorbing capacities—ranging from 120 to 220 pounds of water per 100 pounds of shavings. Shredded corn or sorghum stover make excellent bedding material, being capable of absorbing 250 pounds of water per 100 pounds of material. Dried peat ranks highest of all materials commonly used for bedding, having a water-absorbing capacity of from 500 to 1,000 pounds per 100 pounds of dried peat. Hulls, chaff, and various other materials may be used satisfactorily if dry and clean, but such material as hulls and chaff does not stay in place upon the stall floor as well as the straws.

The amount of straw needed per cow per day varies with the water-absorbing capacity of the material used and the production level of the cows. Heavy-producing cows need up to 50 per cent more bedding than dry cows because of the much larger quantity of water eliminated daily. About 5 pounds of cereal straw is needed daily per average cow in stanchions. For high-producing cows 6 or 7 pounds will be needed. When cows are kept in box stalls or in pen barns, the bedding requirement is increased from 25 to 50 per cent over that for stalls and stanchions.

FEEDING THE MILKING HERD

In *Agriculture II* the fundamental principles involved in feeding dairy cattle, together with rules for feeding milking cows, was considered. Here we shall be concerned with further problems in feeding the dairy herd. Among the more important practical problems that remain to be considered are: the treatment of feeds such as grinding, chopping, and fermenting, the place of roughage in the ration, the place of silage in the ration, pasture and supplements to pasture, feeding cows on limited concentrates, the feeding routine, furnishing water, and furnishing salt and minerals.

Treatment of Feeds. Feeds are frequently subjected to different treatments with the assumption that the digestibility or palatability or both are improved. The most common of these processes are: grinding, chopping, shredding, cooking, soaking, and special digestion processes.

Grinding Grains. Unless grains are very cheap and the cost of grinding very high, it pays to grind grains that are to be fed dairy cattle. Cows do not chew the feeds to any extent before they are swallowed and the grains are too hard to be acted upon by the juices of the digestive tract without first being broken. As a result, varying proportions of the grains pass through the digestive tract without being digested and are lost. From 20 to 25 per cent of oats and 30 to 35 per cent of corn will pass through the digestive tract undigested if these grains are fed whole. When the corn is cracked and the oats are crushed, the losses are reduced to 5 to 10 per cent for the former and 1 to 2 per cent for the latter. For the sorghums and barley even greater savings are made by grinding.

Best results are obtained when feeds are ground to a medium fineness. When they are too finely pulverized their digestibility is lowered. The Purdue Station found that finely pulverized grains produced 5.4 per cent less milk than medium-ground grains, and whole corn and oats, 11.2 per cent less.

Grinding Roughage. A number of experiments have shown that the digestibility of roughages is not increased by grinding; but, on the contrary, is slightly reduced. Ground roughage is also less palatable than the whole roughage. The one advantage of ground roughage is that cows can not select a portion and then refuse it. The cost of grinding, ranging from $1.75 to $3.50 per ton, will not offset this one advantage. The conclusion, then, is that it does not pay to grind roughages.

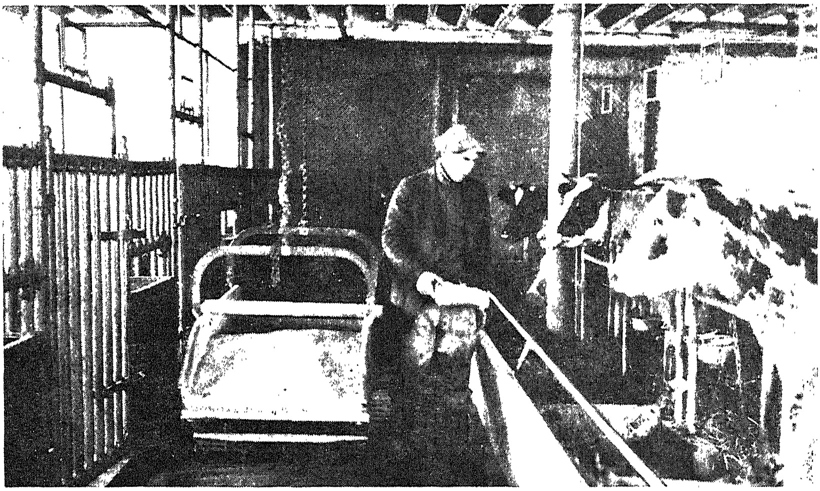


Figure 88. Feeding concentrates from a feed cart run on an overhead track. Note box-stall arrangement on the left.

Chopping. By chopping is meant cutting the roughage into short lengths. Chopping is sometimes advisable for fodders, such as corn and sorghum. The process is not expensive. The cut fodders are easier to handle than when whole and the refused portion makes good bedding. The same advantages hold for shredding fodders.

Cooking. Many persons make a practice of cooking the concentrates fed to the dairy herd, believing that the palatability as well as the digestibility is improved. Although, in some cases, the palatability of feeds is improved by cooking, the difference is very slight. The digestibility is not improved by cooking, and, as the labor and expense of fuel involved are considerable, the practice is not to be advised.

Soaking. Long soaking of hard seeds makes them more digestible, and, in event that facilities are not available for grinding, it may be advisable to soak grains in water for a day or two before feeding.

Special Digestion Processes. There have been offered on the market from time to time several digestive ferments, claiming that, when added to feeds in special tanks, they will increase the digestibility of such treated material. There is no experimental evidence that any ferment will improve the digestibility or value of any feed.

The Place of Roughage in the Ration. Roughage is the cheapest source of nutrients, when grown on the farm, and dairy cattle are better adapted to the use of roughage than any other class of livestock. The basis of the dairy ration is roughage, and, in most cases, it is the chief source of the needed nutrients. The relative yields, total digestible nutrients, and costs of the more important roughages and grains, as reported by the United States Department of Agriculture, are given in Table XLIV: From this Table it is seen that roughages not only yield more per acre than grains, but are much less costly to produce.

TABLE XLIV—THE AVERAGE YIELD OF TOTAL DIGESTIBLE NUTRIENTS AND COST PER ACRE OF VARIOUS CROPS TOGETHER WITH THE CALCULATED COST PER 100 POUNDS OF DIGESTIBLE NUTRIENTS

Crop	*Per Acre*			*Cost per 100 Pounds Total Digestible Nutrients*
	Yield	*Total Digestible Nutrients*	*Cost*	
	Bushels	Pounds	$	$
Corn	49.9	2,283	26.21	1.15
Oats	41.75	941	21.82	2.32
Barley	28.77	1,097	20.96	1.91
Wheat	22.24	1,069	26.05	2.44
	Tons			
Alfalfa hay	2.61	2,694	23.62	.88
Clover hay	1.53	1,558	17.81	1.14
Mixed clover and timothy hay	1.42	1,312	17.39	1.33
Timothy hay	1.23	1,193	15.75	1.32
Soybean hay	1.55	1,662	30.07	1.81
Corn silage	6.27	2,220	38.22	1.72

From this Table it is seen that alfalfa leads all roughages in yields of nutrients per acre and it also has the lowest cost per 100 pounds of total digestible nutrients. With the exception of corn, all roughages exceed all grains in yield of total digestible nutrients per acre and cost significantly less per 100 pounds of total digestible nutrients. Digestible nutrients in oats cost nearly three times as much as in alfalfa hay. Although the clovers and timothy hay do not yield as well as alfalfa, they are still a considerably cheaper source of digestible nutrients than the grains. From these facts it becomes evident that it is good economy to use roughage to the maximum extent.

In order to make the maximum use of roughage, it must be of high quality. What makes for high quality and how it is available in roughages are discussed in *Agriculture II*, page 307 and need not be repeated. When roughages are of average quality, cows will seldom eat more than 2 pounds per 100 pounds of live weight. In the case of high-quality palatable roughages, 3 or more pounds will be eaten daily per 100 pounds of live weight.

There is no set rule as to when roughage should be fed. The important point is that cows be allowed all the roughage they will eat. In order to get the maximum hay consumption, it is necessary that a little more be fed than is completely cleaned up with each feeding. No matter how high the quality of a roughage may be, there is some that is less palatable and is refused. It is a good policy to feed such a quantity that 5 to 10 per cent of the total fed may be refused. The refused portion may be fed to the young stock or the horses.

Silage. The characteristics of silage are treated in *Agriculture II,* page 308. Here we shall consider some special silages and the place of silage in the ration of dairy cows. In recent years there has been a great deal of discussion as to the value of silage in the ration. Experiments have shown that ordinary corn or sorghum silage adds no essential to the ration that may not be furnished by hays. In other words, it has been shown that the so-called succulence of silage is not essential for economical milk production. Whether silage should be provided, resolves itself into the question whether it is an economical source of digestible nutrients. From Table XLIV it is seen that, on the average, corn silage costs nearly twice as much per 100 pounds of digestible nutrients as alfalfa hay. It would appear, then, that silage should not be provided where alfalfa hay is grown economically. In general, this contention can be defended; but, wherever corn is an economical crop, the best way of preserving that crop is to ensile it.

More recently a great deal of interest has been manifested in grass and legume silage. When these materials are put into the silo, it is generally believed that either an acid or molasses must be added to prevent spoilage. Molasses at the rate of 70 to 100 pounds per ton of green material is recommended by some. Others favor a proprietary acid mixture consisting of sulfuric and hydrochloric acids and known as the A.I.V. process. Still others recommend the addition of phosphoric acid. Many put up grass silage without the addition of any material to help in its preservation. Not enough experimental work has been done to permit the proper evaluation of the various methods at this time.

The chief claims for grass silage are that the nutrients are better preserved, that grasses and legumes can be put up as silage when the weather will not permit making good hay, that the yellow pigment (carotene) is better preserved and will produce a richer Vitamin A milk, and that the grass silage will prevent the so-called oxidized flavor frequently experienced in winter milk. For the molasses or acid preserved silages there are evidences to support all these claims, except that the digestible nutrients are increased. It is too early to state definitely the place of grass silage. Where the weather will not permit good haymaking at the time that hays should be cut, grass silage is indicated as feasible.

The quantity of silage to feed depends upon the quantity available, and how much other roughage is at hand. For the average run of silages it requires 3 pounds of silage to equal the digestible nutrients of 1 pound of hay. It is customary to feed 3 pounds of silage to each pound of hay fed, although this ratio need not maintain. When the silages replace legume hay and are of either corn or sorghum, then it must be borne in mind that, as the silage is increased at the expense of the hay, the quantity of protein in the ration is reduced, and it may be necessary to increase the protein in the concentrate mixture. Legume silage or early-cut grass silage are as high in protein content, on a dry-matter basis as alfalfa hay.

If large quantities of silage are fed, it is best to feed it twice daily. As silages impart a flavor to milk, they should be fed after milking. If silage is fed but once a day, it should be fed four or five hours before milking to completely avoid tainting the milk.

Pasture and Pasture Supplements. In *Agriculture II*, page 327, it is stated that milk is produced at the lowest cost on good pasture. There, too, are given recommendations for grain supplements to cows on pasture. We shall now consider further problems in connection with the pasturing of cows, so as to realize their full productive capacity. Among these problems are: the time to turn cows out on pasture, providing shade and water, grazing practice, and furnishing supplemental pastures.

One of the biggest mistakes made in pasture management is to turn the cattle out too early in the spring. Damage is done to both the cows and the pasture. The young grass is so watery that the heavy milking cows can not eat enough to secure the nutrients necessary for body maintenance and the milk produced. As this young grass is stimulating to milk production, milk is produced at the expense of body weight which must be made up later, and then frequently at the expense of milk production. As cows lose their appetite for dry feeds, when first turned out on too young pasture, it is not possible to supplement the pasture properly by feeding in the barn. A more serious damage is done to the pasture. By mowing off the first leaves the pasture gets a setback from which it will not recover during the season. Cows should, therefore, be kept off the pasture until the grass has attained a height of four or more inches.

If it is possible to provide shade for cows on pasture, such should be done. Heavy-producing cows produce a great deal of excess heat from the digestion of the feed that must be eliminated. A shady spot will assist greatly in getting rid of this excess heat while they are resting and chewing the cud.

While the green grass furnishes a goodly portion of the water needs, the water requirements are increased during the hot weather and access to water in the pasture is desirable.

Overgrazing ranks with too early grazing in reducing the yield of pastures. Overgrazing reduces the rate of growth of the herbage for the same reason as too early grazing. It also diminishes the stand, so that the cows can not possibly get a fill, and increases the damage from tramping, for the cows must cover a greater area in an attempt to get a fill.

To avoid the damage from overgrazing, the number of cattle on a pasture should be adjusted to the producing capacity of that pasture or the pasture should be enlarged to accommodate the number of cattle. The latter expedient can sometimes be accomplished by providing supplementary pastures.

One simple method of increasing the yields and, at the same time, to provide a more luxuriant pasture and reduce the damage done from tramping, is to divide the pasture into two or more parts and practice rotational grazing. A very efficient method is to divide the pasture into three parts. The milking cows are pastured first on the more luxuriant growth, then followed by the dry cows and the young stock whose nutrient requirements are much lower. Each group is kept on the pasture for one week, and thus each part of the pasture gets a complete rest for one week out of each three.

Supplemental Pastures. In most parts of the country pasture herbage grows at different rates in different seasons. As a rule, the rate of growth is the fastest in the spring, and, if the number of cattle is just right for the pasture at this time, later in the season, when the growth is materially slowed up, the pasture will be inadequate. The pasture shortage may be made up by feeding hay or silage or increasing the grain allowance, but the most economical method is to furnish a supplementary pasture at this time. Clover, alfalfa, and some of the other legumes are excellent pasture crops for milking cows, except for the danger of bloat. For other supplementary pasture crops see Chapter XIX.

It must be emphasized that the customary decline of milk production during the summer is chiefly caused by insufficient pasture or inadequate supplementary feeds. Although the hot weather and flies are contributory factors to the summer decline in milk production, they are, as a rule, but minor compared to insufficient feed intake.

The Place of Concentrates in the Ration. The characteristics of concentrates are treated in *Agriculture II*, page 309. Here we will consider the place of concentrate in the dairy ration. While concentrates are a more expensive source of nutrients than roughage, as is shown in Table XLV, they are essential in the ration for the best results. Concentrates serve in increasing the total digestible nutrient intake and in supplying some of the deficiencies of the roughage. The total digestible nutrient intake is increased because, on an average, concentrates contain about 50 per cent more digestible nutrients than roughages and also because concentrates are, as a rule, more palatable than roughages, and a greater total consumption of feed results when liberal quantities of concentrates are included in the ration. When low-protein roughages are fed, concentrates furnish the means of supplying the needed additional protein. In addition to these merits, concentrates supply some as yet unknown substance that is lacking in the best of roughages. Recent experiments have shown that the addition of small quantities of grains to a roughage ration increases the milk production out of proportion to the added nutrients, indicating a definite supplementary effect.

The quantities of concentrate that should be added to a ration depend upon a number of factors. The first and most important factor is the quality of the roughage. If the roughage is of poor quality, the nutrient intake from this source will be small because of the poor palatability, and the additional nutrients required must be supplied in concentrates. If the roughage is of such low palatability that only 2 pounds will be consumed for 100 pounds of live weight, then concentrates must be furnished in quantities sufficient to supply the nutrients needed for milk production. For high-quality roughages less concentrate need be fed. As a matter of fact, when the roughages are of high quality and have sufficient protein content, no concentrates need be fed for certain levels of milk production. A schedule for concentrate feeding under such conditions is set forth in Table XLV.

When the roughages are low in protein content, it is obvious that a high-protein concentrate supplement must be fed regardless of how much of the roughage is consumed. If the low protein roughage is of good quality and large quantities are consumed, only small amounts of the high-protein supplement need be fed.

In order to determine how much concentrate should be fed and what the protein content of the concentrate should be, it is necessary to use the feeding standard. For this one should refer to *Agriculture II*, page 323. It is not practical to calculate the rations for each individual cow in the herd, but the feeding standard should be employed in making up the grain mixture and in helping to ascertain the quantities of concentrate that should be fed cows on different producing levels.

TABLE XLV—Production Levels Up to Which No Grain Need Be Fed and the Quantities of Grain That Should Be Fed for Each Pound of Milk Produced Above This Level When High-Quality Roughage Is Fed.

Breed	*Feed No Concentrate Until Daily Milk Production Exceeds:*	*Concentrate Allowance for Each Additional Pound of Milk*
	Pounds	Pounds
Ayrshires	14	0.45
Brown Swiss	14	0.45
Guernseys	12	0.55
Holsteins	16	0.40
Jerseys	10	0.60

A third important consideration in determining the amount of concentrate to be fed is the relative cost of roughage and the concentrate and the price received for the product. It is obvious that, if the cost of the nutrients in the concentrate is as cheap as in the roughage, there is no object in limiting the quantity of concentrates to the minimum.

When and How to Feed Concentrates. The time when concentrates are fed varies with the different routines established in a herd. Many prefer to feed the concentrate immediately before milking, so that the cow will be eating it while being milked. Those that favor this method claim that cows let down the milk better when they are eating their grain. Others prefer to feed the concentrate upon the silage, and still others feed it after milking.

Feeding Cows on Limited Concentrates. Under certain conditions, when high-quality roughage is plentiful and cheap and concentrates are scarce and high-priced, it becomes economically sound to feed mainly roughage, even if the milk and fat production is reduced by so doing. An experiment conducted by the Bureau of Dairy Industry in Montana is summarized in Table XLVI. Three groups of cows were fed on three different planes. One group received only high-quality alfalfa; a second group received, in addition to hay, 1 pound of grain per 6 pounds of milk produced; and a third group received 1 pound of grain for each 3 pounds of milk produced. On the basis of the grain yields and the hay yields the costs and the number of acres required to produce the feed were calculated. It will be seen that it requires more cows on roughage and on roughage and limited grain to produce the same quantity of milk that cows on full grain do, but that the former produces the milk at a lower feed cost.

TABLE XLVI—COMPARISON OF ROUGHAGE ALONE, LIMITED GRAIN AND FULL FEEDING TO COWS SHOWING THE NUMBER OF COWS REQUIRED TO PRODUCE THE SAME AMOUNT OF MILK, NUMBER OF ACRES TO GROW THE FEED AND THE COST OF THE FEED.

Plane of Feeding	*No. of Cows Required*	*No. of Acres Required to Grow the Feed*	*Cost of Producing the Feed*	
			Dollars	*Per Cent of the Full Grain Ration*
Roughage alone	143	402	6,026	74.2
Limited grain	107.3	444	6,834	84.2
Full grain	100	517	8,117	100.0

Further calculations on the basis of the above experiment led to the conclusion that, when butterfat prices were below 30 cents per pound, roughage alone brought the largest returns per cow above feed cost. When butterfat prices were above 30 and below 70 cents per pound, the limited grain ration was the most profitable. Only when butterfat sold for more than 70 cents per pound was the full grain ration the most profitable.

Furnishing Water. Milking cows require more water than any other farm animal. In addition to the water for maintenance, from

3.5 to 5.5 pounds additional water are needed for each pound of milk produced. During warm weather the daily water requirements may be increased more than 75 per cent. When succulent feeds are fed, the water requirements are reduced by the quantity of water contained in the feed. Free access to water at all times is best. The Iowa Station reported that cows having access to water in drinking cups increased milk production by 3.5 per cent as compared to watering twice daily. If drinking cups are not furnished, cows should be watered at least twice daily. When permitted free access to water, cows will drink on an average ten times daily.

Supplying Salt. As all feeds normally fed cows are deficient in common salt, it becomes necessary to supply this element. The quantity of salt required varies with the type of ration fed, the size of the cow, and the quantity of milk produced. For average rations about three quarters of an ounce of salt is needed daily for each 1,000 pounds of live weight and an additional 0.3 ounce for each 10 pounds of milk produced.

Salt may be furnished in different ways. It may be supplied in salt cups, or be fed in the manger daily, or in the form of salt blocks, or part of it may be furnished in the concentrate. In the latter case, it is customary to add 1 pound of salt to each 100 pounds of the concentrate mixture. The way in which salt is supplied is not important, but it is important that ample quantities be furnished regularly. For high-producing cows the salt requirements are so high that they can not get the required quantity from salt blocks.

Supplying Minerals. As the mineral requirements of cattle are discussed in *Agriculture II*, page 328, it is necessary to consider only the method of ascertaining which ones are needed and how to supply them. In the upper intermountain region of this country iodine is deficient in the soil and, therefore, deficient in the crops. Wherever it is needed it is most easily and economically supplied in the form of iodized salt. As the need for additional phosphorous is restricted to areas where the soil is low in its phosphorous content, supplements of this element should not be attempted until it has been ascertained that it is needed. When additional phosphorous is needed, it is supplied most economically in a safe form in bone meal for livestock feeding purposes. When phosphorous deficiency exists, bone meal should be made available at all times. A mixture of 60 parts of bone meal and 40 parts of salt is a satisfactory combination.

MANAGING THE DAIRY HERD

To feed a dairy herd well is by no means all that is necessary to insure good and economical milk production. The effect of good feeding can be largely offset by neglect of a large number of important managerial factors. Among these are the factors that make for the comfort and physical care of the cow, and those involved in the control of vices, reproduction, milking, and disease control.

Making the Cow Comfortable. It has been repeatedly emphasized that the high-producing dairy cow performs an immense amount of work in masticating, digesting, and metabolizing the large quantity of feed essential to furnish the nutrients for her body maintenance and the production of milk. It is obvious that anything that will produce discomfort will reduce the efficiency of the cow, so that milk production will suffer. Exposure to cold, wet weather, cold wet barns or cold drafts results in reduced milk production and often in udder troubles. Exposure to the hot sun likewise reduces milk production.

It is not necessary that a barn be warm, but that it be dry and free from cold drafts. Experiments have shown that a milking cow is perfectly comfortable in barns that are below freezing temperatures and that there is no loss in milk production under such conditions, provided the quarters are dry and free from drafts. The excess heat given off, due to the digestion of the feed, by a high-producing cow is sufficient to keep her comfortable at quite low temperatures. Most people, however, claim that the temperature of a barn should not fall below 45 degrees F.

Regularity. The importance of being regular in the handling of the herd can not be overstated. Cows are quick in forming habits, and, when a formed habit is interfered with, there is a disturbance that saps energy and results in lowered milk production. A definite schedule should be adopted for the work to be performed in the barn and rigidly observed. If cows are in the habit of being fed at a regular hour and the time of feeding is delayed, a state of anxiety is created which results in the loss of nervous energy. The same result obtains for milking, cleaning the barn, and any other routine about the barn.

When cows are on pasture one may observe that they soon develop the habit of coming up the lane at the usual milking and feeding time. If they are not admitted to be milked and fed at the customary time, one can observe their restlessness.

Exercise. For some time it has been believed by many that milking cows should have daily exercise, in order to maintain their health and vitality. Recent experiments have shown that cows maintained in stalls and stanchions have done as well as those that were exercised regularly. Young stock, however, and dry cows seem to be benefited by moderate regular exercise, such as being let out in the yard for several hours every day. There is far more danger from overexercising than from underexercising milking cows. Long walks to and from pasture or in the pasture require energy and feed to supply that energy. The energy expended in exercise detracts from that available for milk production. The good manager sees that cows do not walk more than is absolutely necessary.

Excitement. Excitement of any kind causes the use of nervous energy and lowering of milk production. Among those things that should be avoided in this connection are the chasing of cows by dogs, loud noises, such as shouting, presence of strangers, or any other cause that will excite cows. Avoidance of anything that will disturb is particularly important at milking time.

Grooming. Brushing the milking cows apparently does not increase the milk production, as has been claimed in the past. Notwithstanding this fact periodic or even daily grooming by brushing with a stiff brush is not to be discouraged, for it adds to the appearance of the cow, and removal of dirt in this manner will help in clean milk production.

Care of the Feet. Unless cows walk on fairly coarse soil the hoofs will grow faster than they are worn off. Long toes will be developed and cause a tension on the tendons of the legs, which, in turn, will cause pain, discomfort, and even lameness. Usually, after cows have been confined in the barn for the winter, it becomes necessary to trim the hoofs. Trimming is effected by cutting off the forepart of the toe and rasping off the excessive growth underneath. Cows pastured on peat soils will need similar treatment, as such soil lacks the necessary abrasives to wear down the hoofs as fast as they grow. In addition to causing discomfort to the cow, too long hoofs are likely to be broken, exposing the toe to infection.

Care of the Horns. In some cases it is desirable that the horns of cows be retained, if for no other reason than merely to improve the appearance of the animal. The horns, therefore, should be of the desired shape. As horns frequently do not grow naturally in the desired direction, it becomes necessary to train them. They will respond, provided the training is started early enough. If it is desired to turn the horns more inward, a slight tension on the tips by horn trainers will do so. If it is desired to turn the direction of the growth downward, it may be done by adding a quarter-pound weight to the end of the horn. If the change in direction desired is upward, it is not so easily accomplished. The force must then be upward and may be exerted by means of weights attached to cords that run over pulleys and the free ends are attached to the tips of the horns.

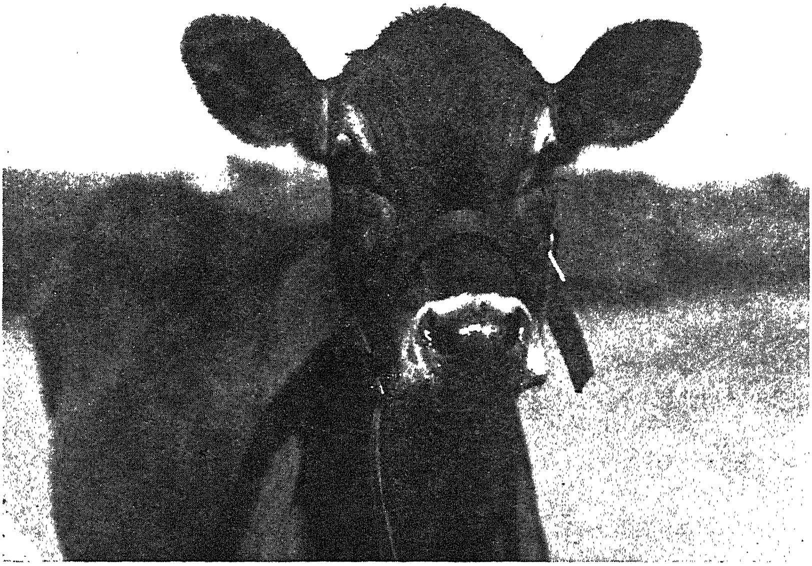


Figure 89. Dehorning, when properly done, need not detract from the attractiveness of an animal.

In all cases training should start when the horn is no more than two inches long. Attention is called to the fact that only slight pressure will cause a change in the direction in which the horn grows.

Scraping the horn near the base on the side toward which the horn growth should be directed is also somewhat effective.

Dehorning. Unless horns are to be retained for show purposes, they had better be removed. They cause a great deal of damage in actual injuries to udders and other parts of animals and from annoyance of one another by the more aggressive members of the herd. The best time to dehorn is when the calf is but a few days old, as described in *Agriculture II.* When the horns are already developed, however, it is sometimes desirable to remove them. They may be clipped off with regular horn clippers or sawed off. The latter way is preferable, as the clipper sometimes causes a crushing of the part of the skull adjacent to the horn and results in severe bleeding and even infection. In removing a horn care should be taken that a ring of skin and hair is taken with the horn, else the horn will grow again.

To avoid the danger of infection, dehorning should preferably be done in the early spring before flies are present. Cattle that have been fed sweet clover within a month should not be dehorned on account of the danger of hemorrhage. Nor is it advisable to dehorn cows in advanced pregnancy. Experiments have shown that milking cows may be dehorned without any appreciable effect upon milk production. As a rule, there is a slight decline in milk production for a few days after the operation, but it soon returns to normal.

Controlling Vices. Cows are sometimes prone to develop some annoying vices. The more common are: kicking, viciousness, fence breaking, and sucking.

Kicking. A large number of cows develop the bad vice of kicking, particularly when being milked. After this habit is developed, it becomes hard or impossible to break, so that it is important to prevent kicking from becoming a habit. As a rule, the kicking habit is developed from mistreatment. At first the heifer or cow kicks because of pain or fear. If beaten when she first starts kicking, a second factor enters and she kicks because she resents the beating.

After a cow has developed the kicking habit, the only treatment is to tie her up, so that she can not kick while being milked. Antikicking chains are the most convenient for this purpose. If they are not available, a rope or strap fastened about the hind legs just above the hocks will do.

Viciousness. Not infrequently cows will attack persons, particularly children. The most effective means of breaking this vice is to strike them sharply over the nose at the time of the attack.

Fence Breaking. Many herds have one or more cows that continually break through fences. At first, cows break through fences because of insufficient feed and because the fences are not well enough constructed. After a while the breaking of a fence becomes a habit which can not be broken. Fence breakers have been confined in barns for years without breaking them of the habit.

Breaking of fences may be prevented by the construction of sufficiently well-built fences that can not be broken. Electric fences are very effective in stopping the fence-breaking habit.

Sucking. Every herd at some time or another has had experience with one or more cows that either sucked themselves or other cows. Just how this vice is developed is not known, but it is thought that one will teach others the habit. It is practically impossible to break cows of the sucking habit, once it has developed. Treatment lies, therefore, in disposal of the offender or in the application of some principles that will make sucking physically impossible. If the sucking cow is not too valuable a producer, her disposal is to be advised.

For valuable producers one of the following methods may be used in preventing sucking. A bridle with a bit of a quarter inch gas pipe drilled full of holes, a chain of two bull rings fastened in the nose or a halter, with a muzzle strap containing sharp points such as sharp nails extending outward. The perforated gas pipe lets in air when sucking is attempted and the act can not be performed. When this method is used, care should be taken that the cow gets water. Usually when the cow gets water from a tank she learns that by inserting the pipe below the surface of the water she can drink. The sharp nails in the halter cause pain when sucking is attempted. The chain of bull rings, although unsightly, is effective in interfering with getting hold of the teats but not with eating or drinking.

Self-sucking cows may be prevented from doing so by another method, the principle of which is to prevent them from getting the head back to the udder. This habit may be cured by fixing a surcingle of rope around the chest, fasten a stick to the surcingle, passing it between the forelegs and fasten the other end to a halter.

Factors Involved in Reproduction. Under this head are included some of the most important managerial factors; for milk production is based upon reproduction. Among the more important factors involved in reproduction are: age at which heifers should be bred, length of rest period, when to breed cows, care of the pregnant cow, care at calving time, care after calving, sterility, and the length of the productive life of a cow in relation to profit.

When to Breed Heifers. The age at which heifers should be bred depends upon their development and the season at which their calving is desired. The average ages for the different breeds at which heifers should be bred, if they are normally developed, are given in *Agriculture II*, page 351. There, too, is given the gestation period of cows. Deviation from this rule should be made, if breeding at the recommended age will cause calving at a season that is not desired. For market milk production it is highly desirous that cows calve at evenly distributed periods throughout the year, in order that the level of milk production may be kept constant. Heifers may, therefore, be bred from one to three months earlier or later than the recommended ages in order to effect this adjustment.

Length of the Rest Period. It has long been recognized that a cow should be given a rest from milking before calving, as, by so doing, the next lactation will commence at a higher level and, with proper feeding and care, the cow will maintain a higher production through the entire lactation period. The proper length of the rest period has been subject to some controversy. As a rule, it may be stated that the production will increase with the increase in the length of the rest period, but the increase is not directly proportionate. Under ordinary conditions a rest period of 40 to 45 days for older cows and 70 to 75 days for first-calf heifers produces the optimum results.

The reasons for better results following a rest period are not entirely known, but it is presumed that the udder needs a period for developing and that during the rest period certain body stores are built up to be drawn upon during the next lactation. The reason that a longer rest period is needed for first-calf heifers than for older cows may be explained on the basis that they need more development of the udder and that, too, there is still growth of the body requiring more nutrients.

Length of the rest periods should be increased, if cows are in poor condition, and for heifers that are not well developed. To offset the effect of too early breeding of heifers, an increase in the length of the rest period is very effective.

When to Breed Cows. As the lactation period advances, the daily milk production decreases and ultimately will stop altogether for most cows. It, therefore, becomes obvious that cows should be bred at a time so that lactation will be renewed early enough to avoid too much of the effect of advancing lactation. Again, they should not be bred so early that the necessary dry period becomes too large a proportion of the interim between calvings. Here again one can not be too specific in stating the optimum time when cows should be bred, for there is a great variation among cows in the rapidity with which milk production drops off with the advance in lactation. On the average, it has been found that breeding so that calvings occur once each 12 months produces the optimum results. Cows, then, should be bred at the nearest heat period to 75 days following calving.

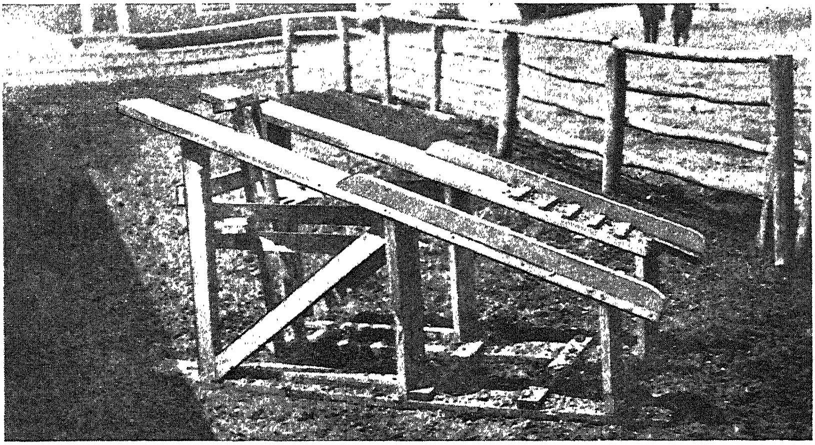


Figure 90. An inexpensive breeding rack. When heavy bulls are used to breed heifers, it is advisable to use the breeding rack.

There are reasons for lengthening or shortening the lactation period. The most important reason is that of desiring to change the season of the year when cows will calve. If the cow tends to fall off rapidly in milk production with the advance of lactation, changing the calving time is most economically affected by shortening the breeding period. If, however, the cow is very persistent, the better way is to lengthen the period between calving and breeding.

Care of the Pregnant Cow. During the first part of pregnancy no special attention is needed for the pregnant cow. During the latter part of pregnancy and particularly during the rest period, cows should be given special attention. Every care must be taken to avoid injury. The pregnant cow should not be hurried. Special precautions should be taken to prevent the cow from slipping on floors or from being forced to walk in deep mud. Exercise is beneficial and it is advisable that she be let out in the yard daily during the winter except in too severe weather.

The most important part in the care of the pregnant dry cow is that of feeding. It has been shown by many investigators that the condition of a cow at calving time determines to a large extent the level of milk production that may be assured after calving. The object in feeding a dry cow, therefore, should be to put her in the best condition of flesh consistent with cost.

A good legume hay is the best roughage, although any other roughage of good quality will do, as the protein requirement is not as high at this period as when in milk. During the pasture season, good pasture is excellent, and, in some cases, where the cow is in good condition to begin with, pasture may be adequate without any concentrate supplement. When the cow is on dry feed, and, in most cases, when on pasture, concentrates should be fed in rather liberal quantities. The quantity of concentrate to be allowed varies with the condition of the cow and the quality of the roughage fed. As a rule, 4 or 5 pounds of concentrate daily is ample. When the cow is in poor condition, 6 to 8 pounds should be allowed daily.

The kind of concentrate is not important, except that it should be the cheapest possible. Only when the roughage is of the low-protein varieties need any attention be paid to the protein content of the concentrate. When the roughage is timothy or similar hay and corn or sorghum silage the concentrate should contain not less than 12 per cent protein. Corn alone is a satisfactory concentrate with legume hay.

As minerals may be stored in important quantities in the animal body, the dry cow should be assured plenty of phosphorus and calcium. It is advisable to furnish the dry cow all the bone meal that she will eat and, in iodine deficient areas, iodized salt should be used.

Care at Calving Time. Two or three days before calving the cow should be removed to a box stall, that she may be accustomed to the new environment. This stall should have been thoroughly cleaned and disinfected beforehand, and should be well bedded with clean straw. Unless thoroughly cleaned the maternity pen may become a dangerous source of infection to both the calf and the cow. The pen is best cleaned by thoroughly scrubbing with a hot lye solution (1 pound of lye to 30 gallons of water). This may be followed by spraying with a solution of any good disinfectant. During the summer a clean lot is the best place for calving.

At this time the concentrate should be changed to a laxative, one of which, wheat bran, is usually recommended. As wheat bran is not very palatable, a mixture of half each of bran and oats is preferred by many. As the time of calving approaches, as indicated by uneasiness, the cow should be left alone but watched for any abnormalities. If calving proceeds normally, any disturbance at this time interferes with the normal progress. If there are evidences of abnormal calving, such as malpresentation (the calf coming in the wrong position), a skilled veterinarian should be called. Any interference by an unskilled person at this time is likely to do more harm than good. If the presentation is normal (head and forefeet first) and delivery is prolonged, assistance should be given by putting traction on the front feet.

Care after Calving. Immediately after calving the cow and the calf should be left alone, unless the calf needs assistance to get milk within one half hour. The calf should be left with the dam for the first two or three days, although not necessarily, if the calf is furnished with its mother's milk. Although the cow should be disturbed as little as possible at this time, she should be watched for any undesirable symptoms. She should be allowed all the roughage she will eat, and the laxative feed given before calving should be continued for two or three days. She should not be given very cold water.

The three most common difficulties encountered after calving are: retention of the afterbirth, milk fever, and congestion of the udder. Normally, the afterbirth should be expelled in four to six hours. If it persists longer, and there are no signs that progress is made in its expulsion, a skilled veterinarian should be called. An inexperienced person may ruin the cow for further breeding by attempting to remove the afterbirth. The afterbirth is attached to the uterus at from fifty to 100 points by what is known as cotyledons, or "buttons," and injury to these points may impair further breeding efficiency. If the afterbirth is not expelled, it will ultimately decompose and the poisonous products will be absorbed, causing loss of appetite, emaciation, and a great reduction in milk production.

Milk fever, or parturient paresis, is a disease that frequently attacks high-producing cows after parturition, although cows may be attacked before calving and at later periods in the lactation. Milk fever may be recognized by a paralysis which begins over the loin and progresses forward until the animal becomes completely paralyzed. Usually, the affected animal will lie with her head bent back against her side and is irresponsive to pin pricks. In most cases the afflicted cow will not survive, unless aid is given. The treatment may be one of two kinds. As the disease is caused by a lowering of the blood calcium, due to the drainage of this element out of the blood, the real problem is to restore the blood calcium to its normal level. Injection, either subcutaneously or intravenously, of 200 to 300 cc. of a saturated solution of calcium gluconate is the most effective. It is the method most commonly used. The other method used by some and which is recommended when calcium gluconate is not available is to inflate the udder with air. For this purpose a special apparatus should be used which will filter the air and which can readily be sterilized. In emergencies where neither calcium gluconate nor the milk fever inflation outfit are available, an ordinary teat tube and an automobile or bicycle pump may be used. In either case air is pumped into each of the four quarters until the udder becomes distended to about the extent of an udder filled with milk just before milking. The pressure of the pumped-in air stops milk secretion and permits the calcium to be built up in the blood from the body stores.

There are two dangers from the air inflation method—one that too much air pressure may be applied and the delicate tissues of the udder injured, and the other, that germs are introduced into the udder by the teat tube or by the air pumped in, and severe mastitis will result. Mainly for these reasons the calcium gluconate therapy is preferred.

As an attack of milk fever will give somewhat of a setback to milk production, it is highly desirable to prevent the onset of the disease insofar as possible. The most effective way of preventing the onset of milk fever is to refrain from milking the udder completely dry for the first four or five days after calving. For susceptible cows it is advisable to remove only the milk required for the feeding of the calf during this period. It should also be pointed out that cows vary in their susceptibility to milk fever and that they become more susceptible after the first calving. Once a cow has had milk fever, she should be watched more carefully for a recurrence after each calving.

Congested Udders. With nearly all well-fed and high-producing cows the udder becomes congested and swollen immediately before and after calving. This condition makes for difficulty in milking and in all probability makes the udder more susceptible to infection. The swelling is due to an accumulation of lymph mainly in the tissues under the skin, which, in many cases, extends on the belly up to the front legs. As the lymph vessels run in an upward and backward direction, massaging the udder with strokes in an upward and backward direction is beneficial.

Some claim that certain feeds, of which corn and cottonseed meal are listed as the worst, cause the congestion more than others. This claim is not borne out by known facts. Feeding has something to do with the difficulty, for only well-fed cows suffer from udder congestion. To reduce the plane of feeding to the level necessary to avoid udder congestion is not advisable, for the very purpose for which feeding is done is defeated, that is, the production will be lowered out of proportion to the inconvenience or the risks involved by the congested udder. Laxative feeds before calving and immediately after calving will do much to reduce the swelling to the minimum.

After the third day following calving, the cow may be started on the concentrate ration that she is to receive during the milking period. As the cow is presumably in good condition of flesh at this time and, as she is also likely to go off feed, it is important to start the concentrate feeding at a low level, say 4 or 5 pounds per day, and gradually bring the daily quantity to as much as will supply the required nutrients. Once a cow goes off feed, all concentrate should be withheld for a day and then the concentrate feeding schedule must start again from the beginning.

Sterility. Sterility, or failure to reproduce, is a problem of no small importance in most dairy herds. Both males and females may be affected either temporarily or permanently to cause heavy losses to the herd. As the bull will be discussed later, only sterility problems relating to the females will be treated here. In Table XLVII is recorded the experience of the University of Minnesota with sterility in the dairy herd for a period covering twenty-nine years. It is typical of the reports of similar studies in other places. It will be seen that one out of every fourteen heifers was sterile, the largest percentage until the 9-year-old class, when one of every thirteen cows became sterile. After ten years of age, the percentage of sterility increases at a rapid rate.

While all the factors contributing to sterility are not known, inheritance and a number of environmental factors are known to be contributory factors. Sterility among heifers can most easily be accounted for on the basis of inheritance. Infections in the reproductive tract, such as Bang's disease, vaginitis, trichomonad disease, and many others are prominent causative factors. Accidents to the uterus during calving and retained afterbirth often cause either temporary or permanent sterility. Nutrition may also be a factor. Phosphorous deficiency has been shown to cause the suppression of heat until the phosphorous level in the system is restored to normal. When dairy cows suffer from phosphorous deficiency, the common experience is for cows to have a calf every other year. During lactation there are no heat periods and not until lactation has ceased is the phosphorous level built up to a point where heat appears and conception may take place. Insufficient Vitamin E in the ration may also be partly responsible for sterility, although more evidence is necessary to establish the place of this vitamin in cattle production.

TABLE XLVII—THE RELATION OF AGE TO STERILITY IN COWS AS REPORTED BY THE UNIVERSITY OF MINNESOTA

Age, years	*Total cows*	*Number sterile*	*Per cent sterile*	*Ratio of sterile to total*
2	311	23	7.4	1:14
3	217	8	3.6	1:28
4	139	5	2.8	1:36
5	127	8	6.3	1:16
6	87	5	5.7	1:18
7	69	3	4.3	1:23
8	56	2	3.6	1:28
9	51	4	7.8	1:13
10	41	2	5.0	1:20
11	34	4	11.7	1:9
12	25	3	12.0	1:9
13	19	4	21.0	1:5
14	12	2	17.0	1:6
15	9	3	33.3	1:3
16	5	1	20.0	1:5
17	2	1	50.0	1:1

Productive Life of a Cow. The length of the productive life of a dairy cow must receive careful consideration. Other things being equal, the longer a cow continues to produce, the more profitable she will be. Figure 91 illustrates this point graphically. In *Agriculture II* it is shown that the cost of raising dairy heifers to producing age is a very important item. If there is but one lactation period, the entire cost of raising must be charged against this one lactation. As the number of lactations increase the charge per lactation for the cost of raising the heifer will be reduced proportionately.

While cows are known to produce and reproduce when more than twenty years of age, the average age at which cows leave the herd is estimated to be about seven years. This figure will allow for about five lactations per cow. Mastitis, Bang's disease, sterility, and other diseases account for about 60 per cent of the cows that leave the herd. From 1 to 2 per cent of the cows die on the farm; 15 to 20 per cent are sold because of low production, and the rest may be accounted for as sold for other purposes.

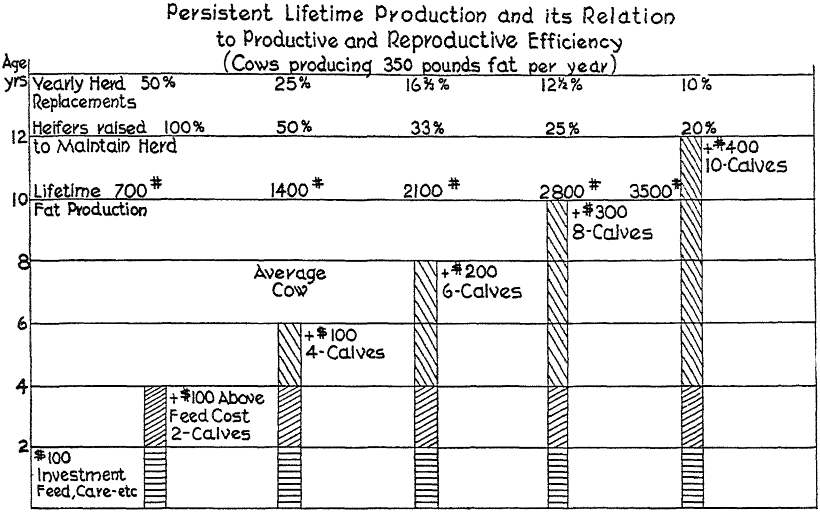


Figure 91. A long productive life is an important character for economical production. The greater number of years a cow is productive, the fewer heifers need be raised for replacement and the less will be the annual replacement in addition to the greater total lifetime production of milk and butterfat.

MILKING FACTORS

Milking factors may be divided into two groups—those that pertain to the mechanics of milking and those that pertain to the other factors that affect the quantity and quality of milk. Under the mechanics will be discussed the fundamentals involved in milking, hand and machine milking, hard milkers, sore and leaking teats, use of the teat tube and drying off cows for the rest period. Under factors affecting the quantity and quality of milk will be treated heredity, stage of lactation, number of milkings per day, the interval between milkings, the progress of the milking, gestation, milking before calving, heat, age, size, season of calving, feed, and mastitis.

The Milking Process. To understand the reasons for the correct milking procedure one must have a knowledge of the physiology of the "letting down" of milk. The whole of milk production by the cow can be divided into two phases. The first of these is the synthesis and secretion of milk and the second is the expelling of the milk which is known as "letting down of milk." Snythesis and secretion are a continuous process in which the milk is stored in the alveoli and tiny ducts of the udder. The "letting down" process is the forcing down of the already-formed milk into the lower ducts and cisterns of the udder from which the milk may be withdrawn by milking.

The "letting down" of milk is a complex process involving the secretion of a hormone known as oxytocin from the pituitary gland. The secretion of this hormone requires a stimulus such as the massaging of the teats in the milking act which stimulus sends a message to the brain and from there to the pituitary gland. The hormone oxytocin is then secreted into the blood stream and carried down to the udder where it causes a contraction of the smooth muscles to force the milk down.

The cow will not respond to the milking stimulus in secreting the hormone if she is frightened, angry, anxious for feed, or in any other emotional state. To get full response to the milking stimulus, it is important that the cow desire to be milked and will co-operate with the milker. A milker who does not enlist the confidence of the cow or any other distractions in the barn during milking time will interfere with the response to the stimulus and will cause an incomplete milking.

Another important point is that, after the oxytocin has been secreted into the blood, its effectiveness lasts for but a limited time, perhaps about seven minutes. If the milk is not removed within this time, an incomplete milking will result and, if such occurs regularly, the cow will gradually dry off. Effective milking, therefore, requires that the cow be milked rapidly, probably within seven minutes.

If a cow is not milked dry either from incomplete let down of the milk or from leaving part of the milk in the udder, there will be a tendency for her to dry off. (For explanation see "Drying-off Cows.")

Hand and Machine Milking. One of the questions frequently asked is that pertaining to the efficiency of hand and machine milking. There is but little experimental evidence as to the relative effectiveness of the two methods in maintaining milk production. The evidence at hand seems to indicate that the best hand milkers will secure a little better results than by machine, but the difference is not great. It is generally agreed that the milking machine, when properly run, will give better results than average hand milking. When cows become accustomed to machine milking, they like that method as well as hand milking. When harmful effects are observed from the milking machine, they are due to one of the several faults in operation. Too high vacuum or leaving the machine on the udder too long may cause injury to the teats. Too low vacuum, leaky inflations, or rubber connections and improper adjustment of the pulsations may result in improper removal of the milk. It is important that the instructions of the manufacturer be carefully followed in order to get the optimum results from the milking machine.

As to whether or not cows should be stripped following the milking machine, there is not, as yet, enough evidence to give a positive answer. Undoubtedly many cows let down all the milk to the milking machine, but there are also some that do not, and it becomes necessary to strip them after the removal of the milking machine. Probably stripping can be omitted if heifers are started out with machine milking.

Experiments have shown that just as clean milk can be produced with machine-milking as with hand-milking, but, that it may be, the machine must be carefully cleaned after each milking. Immediately after the milking is completed, the machine should be rinsed with several gallons of lukewarm water. This rinsing may be done while the vacuum is still on by dousing the teat cups up and down in the rinsing water. Immediately after this rinse, there should be drawn through the machine in a similar manner several gallons of hot water to which has been added two tablespoonfuls of a good cleaning powder. The pail is cleaned and sterilized in the same manner as any other dairy equipment, but the rubber parts must be treated differently. The easiest and most effective way of cleaning the rubber parts is to place them in a sterilizing rack immediately after having been rinsed. The milk tubes and the rubber inflations are then filled with a lye solution which is left there until just before the next milking when the lye solution is emptied and the parts rinsed in cold water. A stock solution of the lye is made by dissolving a 14-ounce can of lye in a gallon of water. The solution to be used in the sterilizing is made by adding one half a pint of the stock lye solution to a gallon of water.

Although it is not necessary, according to most authorities, the rubber parts should be further sterilized by following the lye solution with any good sterilizer, such as some of the various chlorine preparations.

Care of the Milking Machine. In most cases, where the milking machine does not give satisfactory results, the reason can be attributed to the lack of proper care. Like any other complicated piece of machinery, it has many parts that can get out of order and that will wear out fast for lack of attention. The adjustment of the pulsator and the avoidance of vacuum leaks have already been mentioned. The vacuum pump should be oiled and receive care, if it is to give the best service. On the vacuum line drain cocks need to be checked for leakage. The milking machine, pails, and covers should be handled carefully to avoid dents and distortions that will cause leakage of air. The rubber parts, particularly the teat cup liners, should be checked frequently for cracks and replaced whenever defects are discovered. The pipe line should be flushed occasionally to get rid of materials that collect therein from condensation of vapors from the milk. Sometimes the pipe line may be a source of bacterial contamination of the milk because of the accumulation of organic material therein.

Economy of the Milking Machine. As to whether or not the milking machine will be economical in a given herd depends upon the size of the herd and the cost of hand-milking. Studies of the relative amounts of time required for milking by machine and hand reveal that the machine reduces the amount of labor by half. The saving is considerable, but there must be charged against this saving the following items: cost of the investment in the machine, and cost of power and labor to run and to clean it. When all these items are considered, it is concluded that the milking machine is not, as a rule, an economical investment for herds with less than twelve cows. It is obvious that, with increasing size of herds, the milking machine becomes a greater economic factor. Studies in Illinois revealed that for 25-cow herds annual savings by machine milking ranged from $0.46 to $9.55 and for herds above 25 cows the savings per cow ranged from $2.76 to $12.37.

Hard Milkers. Nearly every herd has from one to many cows that are hard to milk. These cows are shunned by the milkers and, because of the energy required to milk them, so much time is frequently required that incomplete milking results. Hard milking is due to too strong sphincter muscles surrounding the streak canal or opening in the end of the teat. Sometimes these muscles may be stretched by what is known as teat expanders. Teat expanders are large teat plugs that are inserted into the opening of the teat after milking is completed and left there until the next milking. When these are used, extreme care must be taken to prevent introduction of organisms into the teat. The teat expanders should be sterilized by boiling for at least 30 minutes and kept sterile until inserted. The end of the teat should be wiped with a chlorine solution before the expander is inserted. The sphincter muscles may also be cut in a delicate surgical operation.

Wart-like growths within the teat may also be the cause of hard milking. The only treatment for this condition is a surgical operation by an experienced veterinarian.

Sore and Leaking Teats. There are many causes for sore teats. Whatever the cause, sore teats are the source of real annoyance in milking. Teats may become chapped from exposure to cold winds or cold damp beds. There are many injuries to which cows are subject, such as wire cuts, bruises, and infections, such as warts and cowpox.

Whatever the cause of the sore teat, the pain may be partly relieved by soaking it in a warm salt solution before milking. The application of salves is also advised. When the teats are badly injured, such as bad wire cuts or severe bruises, milking should be done by means of the milking tube. Whenever the milking tube is used, the same precautions in regards to sterilizing should be taken as were directed for the use of teat expanders.

Leaky teats are caused by the reverse of the cause for hard milkers, that is, the sphincter muscles are too weak. This condition may be improved by surgery. To prevent leakage the teats may be dipped in collodion after each milking so as to get a thin film on the end.

Drying-off Cows. Frequently a serious problem arises in drying-off high-producing cows, so that they will get the proper rest period. The most common method is to reduce the feed markedly and then begin the process by first skipping a milking, then continue to increase the intervals between milkings. During the process the udder should never be milked dry. Actually, the drying-off process is achieved by a building up of pressure in the gland from the accumulating milk until resorption of the milk takes place. The same result may be achieved by merely stopping milking altogether at the appointed time. When milking is stopped, a pressure will quickly be built up in the udder, secretion completely stopped, and the milk gradually absorbed. Some advise that, after milking has been stopped for ten days, the remaining contents of the gland should be removed and the ends of the teats should be sealed with collodion. When the latter method of drying-off cows is used, there need be no reduction in the amount of feed allowed.

Heredity and Milk Production. In order to have high milk production, the cow must first have inherited the capacity to produce a large quantity of milk, and then she must receive proper care. Inheritance and environment must go hand in hand. No amount of feed or care will make a high producer out of a cow that has not inherited the capacity for high production. Again, it does not matter how good the inheritance may be; if the cow is not properly fed and cared for, high production can not be secured. Low production of cows on farms is accounted for by both the lack of the right kind of inheritance and failure to receive proper feeding and care. Authorities believe that both factors are about equally responsible.

Stage of Lactation. The stage of lactation has a marked effect upon both the quantity and the quality of the milk produced. For the first few days after calving, the milk, known as colostrum, differs markedly from normal milk. Colostrum is of a thick consistency, yellow in color, high in protein, low in milk sugar, and rich in antibodies. Its composition is the best nutriment for the newborn calf. In about four days the colostrum has gradually changed to normal milk.

The effect of advance in lactation upon the daily milk production is shown in Figure 92. It will be seen that there is a rise in milk flow for the first month or so after calving and then a slow decline follows to the end of the lactation period. With the rise in milk there is usually a decrease in the fat percentage and with the fall in milk there is an increase. The rate at which cows decline in milk production varies widely. Those that decline slowly are said to be persistent and those that decline rapidly are said to lack in persistency.

In advanced lactation cows often produce what is known as bitter milk. Such milk is normal when drawn; but, upon standing, develops a bitter taste, due to the presence of an enzyme known as lipase which splits the fat and forms soap. The cream of bitter milk will not churn. The development of bitter milk may be prevented by heating the milk to a temperature of 180° F. right after it is drawn, to destroy the enzyme.

Number of Milkings per Day. In most cases, increasing the number of times cows are milked daily will increase the quantity of milk. The extent of the increased milk production with the increased number of milkings depends to a certain extent upon the quantity of milk the cow produces. The greater the milk production, the greater will be the increase. Three-times-a-day milking may increase the milk production as much as 25 per cent over two-times-a-day milking. It has been reported that with some cows four-times-a-day milking increased the milk production 33 per cent over three-times-a-day. These are the upper limits.

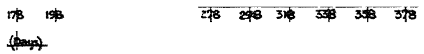


Figure 92. A normal persistency curve, including cows from the Holstein, Guernsey, and Jersey breeds. Note that daily milk production increases for the first 40 days after calving and from that point to the end of the lactation there is a gradual decline in daily milk production.

Under average conditions, the increases would be much less. Milking but once a day, in one experiment, lowered the total milk production to less than one half of that secured by milking twice daily.

The Interval Between Milkings. The intervals between milkings should be as nearly equal as possible. When the intervals are equal, there is a tendency for the morning milking to be a little greater in quantity, but a little lower in fat percentage. When the intervals are 14 hours between the evening and the morning milkings, the morning milking will be from 40 to 50 per cent greater than the evening milking, but the fat percentage will be lower.

The Progress of the Milking. As the milking progresses, the fat percentage becomes greater. The first drawn may contain less than 1 per cent of fat, while the last drawn may contain over 20 per cent of fat. Other constituents do not change with the progress of the milking. Whenever samples of milk are taken for testing purposes, it is important that the cow be completely milked and the whole milking mixed before being sampled. If, for any reason, all the milk present in the udder is not withdrawn at a milking, such a milking will be lower in quantity and the fat percentage still lower. The milking following an incomplete milking will be larger than usual and have a higher fat content.

Gestation. The first five months of pregnancy have no appreciable effect upon milk production. Later, however, pregnancy has a depressing effect upon milk production, varying in intensity with different cows.

Milking Before Calving. Sometimes cows come into milk several days before calving. The udder then becomes distended and some believe that it should be milked out. The reasons given for milking before calving are: the amount of congestion will be reduced, milk production will be increased, and the relief from pressure will help to prevent a break in the attachments of the udder. There is some reason to believe that milking before calving will tend to reduce the congestion and may also tend to preserve the udder attachments. The chief objection to the procedure is that there will be no colostrum, which has been shown to be necessary for the well-being of the calf.

Heat, or Oestrus. The effect upon production when a cow is in heat, or oestrus, varies greatly with different cows. In most cases, there is but a slight effect. In some cases both the quantity and the fat percentage may be lowered markedly, a result, no doubt, of an incomplete let-down of the milk.

Age. The chief effect of age is upon the quantity of milk. From two years of age until maturity at six or seven there is an increase in milk production. After holding a plateau for two or three years, there is a decline with further advance in age. There are correction factors by which the production record for any age may be converted to the mature equivalent. Use of these correction factors is desirable when the production records of immature cows are to be compared with those of mature cows. The age correction factors used by the different breed associations are given in Table XLVIII.

Size. When all other things are equal, there is an increase in production with increase in size of cows. Workers at the Missouri Station found that there was an average increase of 20 pounds of yearly butterfat production for each 100 pounds increase in live weight. Within a breed it has been shown, however, that the increase in production with increase in live weight is not economical, for the increased production is not proportional to the weight increases.

Season of Calving. The season in which a cow calves has some effect upon the production during the year. Cows that calve during the fall and winter generally produce from 10 to 15 per cent higher than those that calve during the spring and summer. While there is no difference between spring and summer calving, those cows that calve in the fall have a slight advantage over those that calve during the winter.

TABLE XLVIII—Factors Used by the Different Dairy Breed Associations for Converting Immature Records to Mature Equivalents

Age When Calving *Years Months*	*Breeds*			
	Holstein	*Jersey*	*Guernsey*	*Ayrshire*
Under 2 yrs.	1.50	1.45		
2 0	1.43	1.36	1.25	1.33
2 6	1.33	1.28	1.19	
3 0	1.25	1.20	1.16	1.22
3 6	1.19	1.14	1.10	
4 0	1.14	1.08	1.07	1.12
4 6	1.10	1.04	1.03	
5 0	1.06	1.02	1.00	1.00
6 0	1.03	1.00		
7 0	1.01	1.00		
7.6 to 9.6	1.00	1.00		
10 0	1.01	1.02		
12 or over	1.05	1.05		

Feed Effects. Feed affects milk production in two ways. It influences both the quantity and the quality of the milk. The effect of proper feeding upon the quantity of milk has been treated elsewhere. Here we will consider the effects of starvation, feed effect upon milk fat, vitamins, flavors, and other constituents of milk.

Starvation. When cows are starved, the most noticeable effect is the rapid decline in milk production, but the composition of the milk is also changed to give it the appearance of having been watered. The content of fat, protein, and ash is increased, but milk sugar decreases. The specific gravity is lowered, giving rise to the suspicion that the milk has been watered.

Feed Effects upon Butterfat. Both the quality and the quantity of fat in milk may be influenced by feed. Green feeds, silage, and linseed-oil meal have a tendency to produce soft butter. Dry forages and cottonseed meal produce hard butter. A number of fats, if fed in large quantities, will increase the fat percentage of milk. Among these fats are: corn oil, cottonseed oil, peanut oil, and linseed oil. Cod-liver oil has the opposite effect, in that, when fed, it will lower the fat content of the milk.

Vitamins. The quantity of Vitamin A or carotene in the milk is directly dependent upon the quantity of carotene in the feed. When cows are fed upon bleached roughage with or without grain, the Vitamin A and carotene content of the milk is very low. When cows are on green pasture, the milk fat becomes high in color, on account of the high carotene content of the green grass. Grains contain little or no carotene, but hays that have cured to a bright green color and acid or molasses-preserved silage are good sources of carotene during the winter.

While cattle synthesize Vitamin C, milk may be enriched in this vitamin by feeds, such as young growing grass.

The quantity of Vitamin D in milk is dependent upon the Vitamin D in the feed and the amount of exposure of cows to the direct rays of the sun. During the winter, when cows are confined in barns, the only source of Vitamin D is the cured roughages. In the summer, when cows are on pasture, the chief source of Vitamin D is exposure to the sun, as the growing grass contains none or very little of this vitamin.

Feed Flavors. Practically all the flavors in the milk come from the feed. Some of them are desirable, giving flavors we commonly regard as normal. Others impart undesirable flavors, attributable to onions, cabbage, turnips, frenchweed, ragweed, pepper grass, rape, mustard, and many others. Silage imparts a flavor that is objectionable to many. Rye pasture and sometimes regular grass pastures impart undesirable flavors. Whenever a feed imparts objectionable flavors to the milk, such feed should be fed after milking, so that the effect may wear off before the next milking.

When a feed produces a flavor in milk, the flavoring compound passes from the digestive tract into the blood and from there into the milk. For most of these flavoring compounds, if not all, the concentration of the compound in the milk is the same as that of the blood. When the concentration in the blood is lowered, then the compound passes from the milk into the blood, which accounts for the disappearance of the flavor, if the feed causing the flavor is fed a sufficiently long time before milking.

Other Constituents Passing into the Milk. There are many substances in feed that pass into the milk in a manner similar to that just described for the flavoring substances. A few of the more important ones will be mentioned. Iodine, while normally present in milk in very small quantities, may be increased by the feeding of this element. From 3 to 20 per cent of the iodine fed may be recovered in the milk. Boric acid, arsenic, mercury, and bromine, that are not normally present in milk, may be detected, if these elements are fed.

Ether, chloroform, alcohol, aloes, and a substance found in rhubarb will pass into the milk, if ingested by cows. A poisonous substance, tremetol, found in white snakeroot, will pass into the milk in sufficient quantities to be toxic, when cows eat any considerable quantities of the weed.

Effect of Mastitis. Mastitis, garget, or mammitis, are three terms meaning the same—an abnormal or diseased condition of the udder. There are many different types and degrees of severity of mastitis the details of which can not be considered here. Mastitis is very common among dairy cattle and causes greater losses than any other disease which afflicts cattle.

Losses from mastitis come from lowered production, lowered value of the milk, and from deaths of cows sometimes afflicted with unusually severe types of the disease. There are no reliable figures to show the losses in milk production due to mastitis. Almost without exception milk production is reduced when cows become infected with the disease, no matter how mild it may be. In more severe types, the infected parts are destroyed and the losses are proportionate to the number of quarters destroyed. A probably greater loss comes from the loss of milk the composition of which, as an effect of the disease, has become changed.

Milk from quarters or udders affected with mastitis differs from normal milk in composition directly in proportion to the severity of the disease. The more important characteristics of mastitis milk as compared to normal milk are:

1. Mastitis milk is alkaline, while normal milk is acid. Advantage of this characteristic is taken in the brom-thymol-blue test the dye in which changes to blue when alkaline.

2. The milk sugar is lowered in direct proportion to the severity of the disease.

3. The butterfat content is usually lowered.

4. The casein content of the milk is lowered and the other proteins of the milk are increased.

5. The cell count of the milk is markedly increased. Mastitis,

therefore, can be discovered by the use of a microscope, when the number of cells can be easily determined.

6. The physical character of the milk is usually changed. In mild cases it is likely to contain small clots. In severe cases it becomes thick, lumpy, or stringy, and often yellow.

Many cases of mild mastitis can not be detected without the application of some one of the several different tests for the disease. No one of the tests can be said to be infallible. They should, therefore, be regarded mainly as aids in detecting the disease. Two of the commonly-used tests have already been mentioned—the brom-thymol-blue test and the microscopic test. Sets for making the brom-thymol-blue test may be purchased and anyone can learn to make it. The microscopic test can be made only in laboratories equipped for this purpose.

Another simple test that can be made on the farm by anyone, and that is inexpensive, is the so-called strip-cup method. Strip cups may be purchased or improvised on the farm. A satisfactory one may be made from a piece of black muslin tied around the top of a 5 or 6-inch can. Two streams of milk from each quarter are forced through the muslin and examined for the presence of small white flakes or particles which are a positive indication of the presence of mastitis. This method is not infallible, as a cow may be infected with mastitis when flakes are not present on the muslin.

Another method used in detecting and diagnosing mastitis is a physical examination of the udder. To perform such an examination requires skill and experience. The presence of lumps in the gland tissue is regarded as positive evidence of the presence of mastitis.

Treatment of Mastitis. As yet there is no known sure treatment for mastitis. In some cases, the oral administration of 500 to 700 grains of sulfanilamide daily for four or five days has been effective. In the main, however, the problem is one of prevention. It is important in efforts to prevent this disease to avoid injuries to the teats and udders; for an injury is one of the most important predisposing factors. General sanitation in barns and yards tends to keep the disease at a minimum.

While it is not definitely known how the disease spreads, there are certain procedures that should be followed after one or more cases of mastitis are discovered in a herd. First, the infected cow should be separated from the healthy ones either by disposing of her, if not valuable, or by placing her in an isolation barn or in one end of the regular barn. Secondly, infected cows should be milked last, and, thirdly, the milk from infected cows should be disposed of where healthy cows can not come in contact with it either directly or indirectly. Lastly, all utensils, such as milking machines and pails that have come in contact with milk from an infected cow, should be thoroughly sterilized before they come in contact with healthy cows. The hands of the milker should also be thoroughly washed with soap and water after contact with the udders of infected cows.

DISEASE CONTROL

It is not the purpose to give an extended treatment of diseases that afflict dairy cattle nor even to try to give directions for the diagnosis or treatment of specific diseases; for, to become competent in this field, requires long special training. It is the object to consider the problem of disease from the standpoint of management of the dairy herd and to emphasize the management factors in the control of disease. A consideration of the medicine cabinet and some of the precautions that should keep the herd free from the more common diseases will be included.

The losses to dairymen from disease is an enormous figure and anything that can be done to minimize it in a herd will effect great savings. The more common diseases affecting calves were discussed in *Agriculture II*, and the diseases of the udder and other factors affecting sterility have also been considered.

Disease Prevention. In any disease-control program the most satisfactory and most economical approach is that of preventing the disease. For many of the livestock diseases there are no cures and the only problem is that of prevention. In most other diseases the cost of treatment and losses from production are so great that the cost of prevention measures will seem relatively small.

One of the frequent problems in the management of a herd is how to prevent the introduction of disease upon the premises. When animals are purchased, they should be tested for those diseases for which efficient tests are available; they should be purchased only from herds known to be free from infectious diseases; and, as a further safeguard, new additions to the herd should be isolated from the rest of the herd for at least 30 days and then allowed to mingle with the herd only after having again passed tests for the various diseases for which there are reliable tests.

The tests that should always be applied are: the tuberculin test, test for Bang's disease, and for Johne's disease. The herd from which the purchases are made should be known to be free from these diseases as well as from all others. No purchases should be made from herds that have mastitis, hemorrhagic septicemia, blackleg, trichomonad disease, lumpy jaw, or any other infectious diseases.

A second means of preventing disease is strict sanitation. Dirt and darkness are the habitation of disease organisms, and cleanliness and sunlight are their natural enemies. Cleanliness must not be confined to the barn, but should be extended to the yards and lanes. Dirty or muddy yards and lanes are common places for harboring disease organisms and these are places with which the cattle constantly come in contact.

A third factor in disease prevention is maintenance of the herd in a good nutritional state. Many infectious diseases, of course, have no regard for the nutritional condition of the animal, but many noninfectious diseases are dependent upon a poor nutritional state for invasion. Well-nourished animals also suffer less from disease than poorly-nourished ones, should they become infected.

Drugs and Instruments. While, in the event of the invasion of disease in a herd, a competent veterinarian should be called, every dairy barn should have a cabinet equipped with certain instruments, drugs, and disinfectants. The following drugs should be present: tincture of iodine, a 5 per cent solution of silver nitrate, medicated vaseline, Epsom salts, and a quart of mineral oil. Of instruments, the following should be provided: a clinical thermometer, a trocar and cannula, a drenching bottle, a set of milk tubes, a set of teat plugs, and a syringe. Of the disinfectants, a concentrated solution of hypochloride and a bottle of lysol should always be at hand in the dairy barn.

While space should be provided in the cabinet for medicines that may be prescribed by the veterinarian, it is not advisable to stock the medicine cabinet with a lot of drugs. Many drugs deteriorate with standing.

THE MORE COMMON DISEASES OF DAIRY CATTLE

In addition to the calf diseases and the diseases of the udder, several of the more prominent diseases afflicting dairy cattle must be considered briefly. Among these are tuberculosis, Bang's disease, Johne's disease, trichomonad disease, hemorrhagic septicemia, bloat, pink eye, foot rot, lumpy jaw, and sweet clover disease.

Tuberculosis. Tuberculosis was at one time one of the most widely spread diseases affecting cattle. As a result of an intensive campaign for its eradication, tuberculosis has been reduced to a very low percentage among cattle. Both from the standpoint of the losses incurred, and because persons may contract it from consumption of the raw milk of infected cows, this disease requires unceasing attention.

The disease is caused by a specific organism, *Tubercle bacillus.* This germ may be spread by contact of infected animals with healthy ones, by other animals as carriers, and may be picked up from infected premises. In order to control the disease after an outbreak, all these avenues for reinfection must be thoroughly checked.

Tuberculosis is a slow-developing disease with no apparent symptoms until the disease is advanced. It is not often the cause of death of cattle, but it is destructive of an animal's vitality and efficiency while, also, it renders the milk unfit and dangerous for human consumption. The lungs and lymph glands are most commonly attacked by the disease, although no part of the body is immune from its attack. Whenever a tissue is infected with tuberculosis, small nodules, or tubercles, are formed, and from these the disease gets its name.

Tuberculosis has been controlled and nearly eradicated from this country by testing for its presence and then disposing of the infected animals for slaughter. The test for tuberculosis consists in application of tuberculin to the eye, under the skin or between the layers of the skin, and watching for the reaction. Infected animals develop typical inflammation in the eye to the eye test, a characteristic rise in temperature to the subcutaneous test, and a swelling at the point of injection to the in-between the skin, or intra-dermal, test.

Bang's Disease. Bang's disease, or abortion disease, ranks as one of the leading diseases from the standpoint of the economic losses caused the cattle industry. It is a highly infectious disease caused by the organism *Brucella abortus.* The damage from it results in loss of calves, lowered milk production, and increased sterility.

Although not all infected cows abort, a large portion of them lose their calves. Abortion may occur at any time, but most frequently at about the seventh month of gestation. Following an abortion, cows produce from 20 to 50 per cent less milk than after a normal calving.

Once cows are infected, they usually remain so even though there may be no symptoms of abortion. As a rule, more than 75 per cent of aborting cows will abort but once.

The avenue of infection is mostly through the mouth. Infected animals spread the infection about the premises where healthy animals pick it up. The organisms may be carried by drainage water, other animals, and people working with infected animals. In control of the disease it is imperative that every means be taken to prevent infection through these sources as well as to prevent physical contact of healthy animals with those that are diseased.

Cattle are tested for Bang's infection by what is known as the blood test. This consists in taking blood samples from each animal and mixing the serum with a suspension of the Bang organism. If the blood comes from animals that are infected, the serum will cause clumping, or agglutination, of the organisms. As with tuberculosis, there is no known cure for Bang's disease. Recent developments in the field of vaccination give some promise of immunity. While more experience has to be gained before it can be positively stated that vaccination is the solution to the Bang's problem, the work with calfhood vaccination with the so-called strain number 19 is very promising. To be effective, calves should be vaccinated when from three to seven months of age.

Johne's Disease. Johne's disease, or para-tuberculosis, as it is sometimes called, is caused by an organism similar to the *Tubercle bacillus* and, like tuberculosis, is very infectious. The disease develops slowly, attacking chiefly the digestive tract and causing diarrhea. There is no cure for this disease. Control lies in testing for the presence of the diseased animals and eliminating them from the herd.

Trichomonad Disease. Trichomonad disease is a new one that is becoming widely spread. It is caused by a protozoan which localizes in the genital tract of both sexes. The bull becomes infected from serving infected females and then transmits the infection to others. In the cow the disease causes temporary or permanent sterility and may cause cows to abort.

As yet there is no known cure for the disease. Control is effected by making sure that any animal brought on the farm is free from the disease.

Hemorrhagic Septicemia. Hemorrhagic septicemia is a highly infectious disease found in all parts of the country. It is also known as shipping fever or stockyard disease. It attacks animals of all ages, but young stock is more susceptible. The disease gets its name from the fact that it causes pin-point hemorrhages on the internal organs.

High fever usually accompanies the disease. The immediate cause of death is usually pneumonia. Treatment consists in keeping the infected animal warm and in the administration of either vaccine, bacterin, or aggressin. Healthy animals in a herd in which infection has developed should also be treated with one of the vaccines or bacterins.

Bloat. Bloat, or hoven, is caused by accumulation of gases in the rumen, causing such a pressure upon the chest that respiration is stopped and the action of the heart is affected. While different feeds, such as concentrates, particularly a heavy corn ration, may cause bloat, it is far more commonly attributable to legume pasture, especially alfalfa. In the early stages of the development of bloat regurgitation and the elimination of the gases may be effected by placing a large rope in the mouth and walking the animal. The presence of a rope causes chewing which in turn stimulates regurgitation.

When the gases have accumulated to such an extent that the animal walks with difficulty, the only way to bring relief and save the animal's life is to puncture the rumen wall and let the gases escape. The puncture is made by a trocar and cannula inserted through the abdominal and rumen walls on the left side just back of the last rib and two thirds the way up the side. When no trocar and cannula are available, any knife will do.

Many claim that the danger of bloat may be lessened if cattle have had plenty of water and some dry feed before being turned to pasture on a bloat-producing crop.

Pink Eye. Pink eye is a very infectious disease that affects the eyes of cattle of all ages. The eyes become swollen, inflamed, and filled with matter. The disease causes considerable pain, and milking cows drop sharply in milk production when infected. In many cases the disease, if not properly treated, may cause permanent loss of sight. The infection occurs during the summer and is spread by flies.

Control of the disease consists in removing the infected individuals into a darkened place where flies can not contact them and in thus reducing the chances of spreading the disease to healthy animals. The infected eyes should be washed with a saturated solution of boric acid. A few drops of a 10 per cent solution of argyrol should then be placed in each eye.

Foot Rot. Foot rot is a very troublesome affliction in many herds, causing great lowering of milk production. It is caused by a pus-forming organism that gains entrance through abrasions of the skin between the hoofs. The infection causes great swelling and intense pain. A foul odor also accompanies the infection, giving rise to the term "foul-in-the-foot" as it is often called.

Foot rot is found only where the barns and pens are not clean or where the cattle walk through mud in the yards or lanes. The difficulty may be prevented by cleaning the places where cattle are kept. Treatment of infected animals consists, first, in their removal to clean, dry quarters. Next, the infected hoofs should be thoroughly cleaned with warm soap and water, and the crusts should be scraped away. After thorough cleaning, the infected parts should be treated with a disinfectant, of which a solution of one of the lysols is recommended. If the foot is badly infected, a competent veterinarian should be called.

Lumpy Jaw. Lumpy jaw, or actinomycosis, is an infectious disease caused by a fungous organism. While the attack is most commonly found on the lower jaw, other parts of the body may be affected. The disease starts with a small lump on the jaw that is at first free, but that, later, grows in size, and becomes attached to the jawbone. After some time, the swelling breaks open and pus is discharged. As the pus discharge contains the organisms that cause the disease, it becomes a source of spreading the infection.

Unless an infected animal is worth more than average value, disposal for slaughter in the early stages of the infection is to be recommended. For more valuable animals, treatment with iodine should be undertaken as soon as the disease is diagnosed. This consists in giving 1½ drams of potassium iodide daily until the animal shows a dry scaly skin, begins to appear weak, and loses its appetite, when the treatment should be discontinued for a few days. The symptoms of iodine poisoning usually appear after the above doses have been administered for about one week.

When milking cows are treated, the milk can not be used during the treatment, as the iodine passes into the milk.

Sweet-clover Disease. In those sections of the country where sweet clover is grown extensively for forage, losses are incurred from a disease caused by a certain type of spoilage to either the hay or silage but does not result from consumption of the plant as pasture. The disease causes a destruction of the clotting power of the blood of the affected animals, so that they may bleed to death from minor injuries. The injuries may be internal or external. In some cases a small injury to some internal organ may cause leakage of all the blood into the body cavity. In some cases, large swellings may be noted under the skin from blood that has accumulated there as the result of the rupture of blood vessels from a bruise.

Where either sweet clover hay or silage is fed, one should be certain that it is of high quality and shows no signs of spoilage. As an additional precaution, cattle that have been fed sweet clover hay or silage should not be dehorned or be operated upon because of the danger of hemorrhage, until they have been off the sweet clover for at least two weeks. Cows in the later stages of pregnancy, likewise, should not be fed sweet clover hay or silage.

CARE AND MANAGEMENT OF THE BULL

It is frequently said that the herd sire is one half of the herd. This saying is literally true, for the sire contributes half of the inheritance to his offspring and he is the sire of the whole calf crop in the average herd. While he contributes no more to the offspring than the dam, the fact that he is the sire of many calves in one year while the cow is the dam of but one calf in a year makes the importance of the herd sire in herd improvement obvious. Only one good bull need be selected to accomplish the same thing that would require the selection of all good cows. The factors involved in the selection of a desirable herd sire will be considered in another year.

Here we shall be concerned with the proper care and management of the herd bull. The factors involved are: the proper housing, yards, feeding, cost, handling, and exercising.

Housing and Yard for the Bull. It is not necessary that the bull be furnished with a warm barn. The requisites for the bull pen are that it be dry, free from drafts, and that it be sufficiently substantial to contain him. It may be a part of the dairy barn or a separate building or shed. One essential feature about a satisfactory bull pen is that it be located where there is easy access to a yard and that it permits the construction of a strong and safe pen.

There are many possible and different plans for a satisfactory bull pen and yard. One, illustrating the essential features, is reproduced in Figure 93. The pen there illustrated may be either in a separate building or in the dairy barn. The more important essential features are the dimensions (12 feet square), the concrete manger located in a corner, and the door leading directly to the yard and operated from outside the pen by means of ropes.

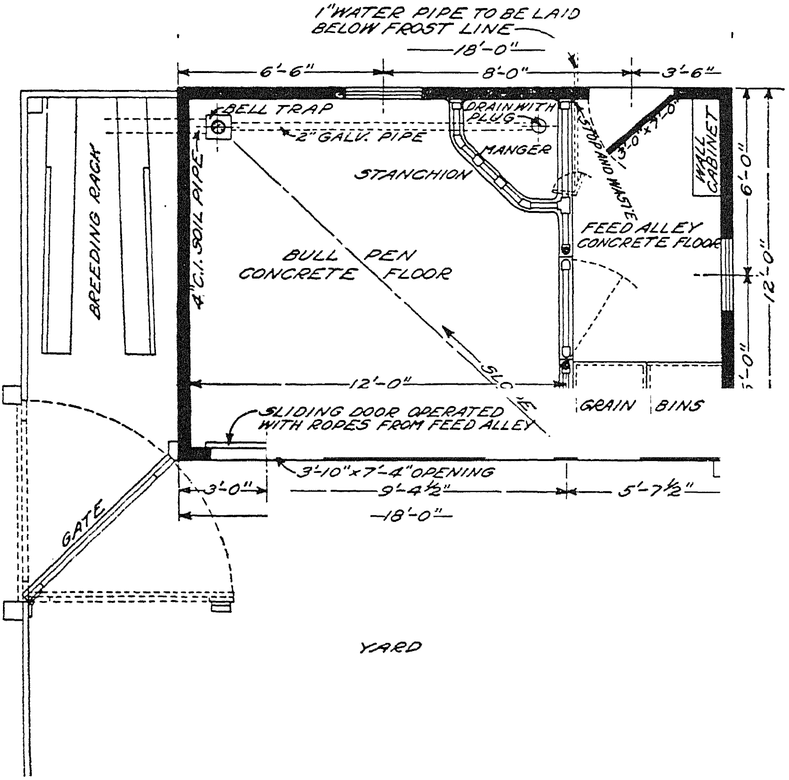


Figure 93. A well-planned bull pen connecting with the yard. Note the arrangement for the breeding rack. This pen may be built in one corner of the dairy barn.

The special feature about the yard is the breeding rack arrangement which permits the breeding of cows without handling the bull. The bull yard should be large enough to permit exercise. A width of less than 24 feet and a length of less than 50 feet is not desirable. The fence surrounding the bull yard should be sufficiently well built to prevent the bull from breaking through. It may consist either of woven wire or of plank. The yard should be well drained and have a layer of cinders or gravel which will help to keep the hoofs worn down.

Feeding the Bull. The object in feeding a dairy bull is to keep him in the best possible breeding condition and to promote growth in the immature bull. The chief difference between feeding a young bull and a mature bull is that the young bull needs more nutrients per unit of liveweight and slightly more protein. The guide as to the quantities to be fed is the condition of the bull rather than any hard and fast rule.

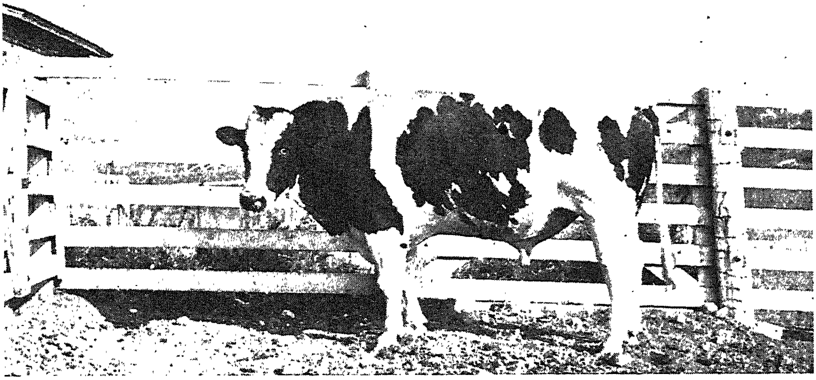


Figure 94. The bull pen should be of rigid construction.

In general, the bull needs both roughage and concentrate. For the mature bull the feed requirements are slightly higher than maintenance requirements, and theoretically should be furnished by roughage alone. Most people, however, believe that the roughage should be somewhat more limited, else breeding efficiency may be impaired. It is, therefore, necessary to furnish some concentrate. Silage may be fed in limited quantities. Table XLIX taken from a report of the Minnesota Station, gives the quantities of hay, silage, and concentrate found satisfactory to maintain mature service bulls of the different breeds.

When the hay is a legume, the grain may be of any kind. If the hay is a nonlegume, from 20 to 25 per cent of the concentrate mixture should consist of some high-protein feed, such as linseed-oil meal or cottonseed meal. During the growing season it is well to supply the bull with some green feed.

Handling the Bull. Dairy bulls are dangerous animals, killing and injuring many people each year. Regardless of how "gentle" one may seem, no chances should be taken, for the so-called gentle bull frequently becomes vicious. The best way is to construct yard and pen arrangements, so that it will not be necessary to handle the herd sire. Such arrangements are presented in Figure 93. Whenever a bull must be handled, it should be done with the aid of a staff, and, in some cases, it may even be necessary to use a harness that hobbles him.

TABLE XLIX—DAILY RATIONS FOR HERD SIRES REPORTED BY THE UNIVERSITY OF MINNESOTA

Breed	*Alfalfa Hay*	*Corn Silage*	*Concentrate*
	Lbs.	Lbs.	Lbs.
Winter Feeding			
Jersey	12	8	4.5
Holstein	18	14	5.0
Ayrshire	16	12	5.0
Summer Feeding			
Jersey	12	5	5.0
Holstein	14	13	5.0
Ayrshire	12	12	5.0

Regardless of whether or not one intends to handle the bull, special effort should be made to prevent him from becoming vicious. While most dairy bulls will develop viciousness, regardless of how they are handled, a bull may be so treated as to minimize the chances of his getting mean. The first and most important principle is not to tease or play with him, but to treat him firmly and be sure that he is made to do whatever is asked of him. Once a bull discovers that he can get by with disobedience, he will be more difficult to handle.

Ringing the Bull. Every bull should be "ringed," that is, have a ring placed in his nose. It is a good plan to first place a light ring in the nose of the bull calf at about six months of age. The calf may then be handled from the ring and get accustomed to being handled that way. When a year or more of age the lighter ring should be replaced by a heavier one.

The best way to "ring" a bull is by means of a trocar and cannula. The bull is securely fastened and the trocar and cannula is inserted through the septum in the nose, when the trocar is withdrawn, leaving the cannula or sheath in place. Next, one end of the ring is inserted into the opening of the cannula and pulled through the opening in the nose, when the ring can be properly assembled. With a larger ring in place and the smaller one removed, it is not necessary to enlarge the opening in the septum of the nose.

Dehorning. Unless horns must be retained for show purposes, the bull should be dehorned. Many people believe that the bull calf should not be dehorned, but that the horns should be permitted to grow for about eighteen months. At this time the bull has become quite accustomed to the use of his horns and, if taken off, he will feel lost without them. Some claim that vicious bulls have become quite docile after the removal of the horns. The horns should be sawed off as directed for dehorning cows.

Exercising the Bull. One of the big problems in the management of a bull is to see that he gets adequate exercise. It is quite well established that, unless he is sufficiently exercised, his breeding efficiency will be impaired. In most cases, it is not enough to furnish the bull with sufficient yard space, but some provision must be made for exercising him. On most farms it is not practical to spend an hour or more each day to exercise the herd bull, so some means of stimulating him to take his own exercise is much to be preferred. For some bulls a suspended block of wood in an easily accessible place in the yard furnishes the incentive for exercise. Bulls will often get the required exercise by playing with the swinging block of wood. Another means, somewhat similar in principle, is to fasten a steel barrel by means of a five or six-foot chain to a buried anchor in the middle of the bull yard. The average bull will take a great deal of delight in bunting this barrel around and incidentally get the required exercise.

In some cases, the bull is broken to harness and then used daily in hauling material around the farm for the necessary exercise. In a few cases, he is trained to work the treadmill and thus to perform useful work. In other cases, special contrivances are used for exercising bulls. One of these consists of a sweep driven by an electric motor, and the bull is securely fixed to one end of the sweep.

Where one or more young bulls are also kept, the old bull may be well exercised by turning the young bulls in with him. When the young bulls are less than one year of age, there is little danger of injury to any one. Older bulls may be kept in the same pen, if there are three or more. It is usually not safe to leave two large bulls alone in a yard, as they are very likely, sooner or later, to engage in mortal combat.

Trimming the Feet of the Bull. Because the bull is confined in a relatively small pen the year around, the hoofs grow more rapidly than they are worn off, and it becomes necessary to trim them. Unless the hoofs are trimmed, great strain is placed upon the tendons in the back of the legs, and lameness results, to impair the breeding ability of the bull.

The hoofs of the bull are trimmed as directed for the cows.

Cost of Keeping the Herd Bull. Only approximate figures can be given for the cost of keeping the herd sire, as the figures vary greatly under different conditions. Some figures presented by the Bureau of Dairying are given in Table L for representative Holstein and Jersey bulls. It will be seen that the feed cost varies with the size of the bull, the larger Holstein bull requiring proportionately more feed than the smaller Jersey bull. The housing and labor costs are the same for both. Investment and depreciation costs are proportional to the initial cost of the bull. The depreciation would be greater for the smaller bull, if the initial costs of the two were the same, for the smaller bull will have a lesser salvage value when sold for beef.

TABLE L—THE ANNUAL COST OF FEED, HOUSING, AND LABOR IN THE KEEPING OF THE HERD SIRE.

Item	*For Holstein Bull Weighing 2,500 Pounds*		*For Jersey Bull Weighing 1,800 Pounds*	
	Amount	*Value*	*Amount*	*Value*
Hay @ $15.00 per ton	7,500 lbs.	$56.25	5,400 lbs.	$40.50
Grain @ $25.00	2,000 lbs.	25.00	1,500 lbs.	18.75
Housing, bedding		22.80		22.80
Labor @ 25c per hour		6.75		6.75
Total		$110.80		$88.80

It is to be emphasized that the cost of keeping a herd sire is a considerable item. For small herds, provided that satisfactory bull service can be secured, it is more economical to hire the neighbor's bull. The high cost of keeping a herd bull is also a factor in favor of bull associations or artificial insemination rings.

Other Important Facts. There are other important facts that should be known in order to properly manage the herd sire. Among these are the age at which a bull may start breeding, how frequently a bull may be used, the length of the service life of a bull, and the relation between the age of the bull and the quality of the offspring.

A well-grown bull may be used for a service per week when 10 to 12 months of age. Undersized bulls will not be ready for service until several months later. At two years of age a well-grown bull has reached the maximum breeding capacity, which is maintained until 6 or 7 years of age, when there is usually a decline until he is no longer serviceable. As many as five cows may be bred per week but only for a short season. For very vigorous bulls more than a hundred cows may be served in a year without any apparent impairment of the breeding powers.

Bulls remain breeders for about the same length of time as cows, but a bull is not often disposed of because he is a non-breeder on account of advanced age. Studies in Iowa revealed that among purebred herds bulls were used for service on an average of only 2.2 years.

One of the great tragedies of the dairy business is the disposal of the bull before his daughters have come into milk and before there is any evidence as to how he transmits production. Very frequently it is discovered that the daughters of a bull are phenomenal producers after the bull has been slaughtered.

There are many misconceptions regarding the age of the sire and the quality of the offspring. Numerous studies have revealed that there is no relation between the age of the sire and the quality of the offspring. There is another popular belief that some bulls will sire mostly heifers and that others will sire mostly bull calves. There is no scientific evidence to support such contention. The sex of the calf is determined by chance alone.

HANDLING AND CARE OF THE MILK AND CREAM ON THE FARM

It is not only necessary to produce milk or cream economically upon the farm, but it is essential to handle and care for the product in such a manner that it will have a good market. It is well known that the market price for dairy products varies with the quality of the product. The quality of the dairy product on the market, whether it be milk, cream, butter, or cheese, depends upon the quality of the milk or cream coming from the farm. All too often too little attention is paid to the proper care of dairy products on the farm. The production of dairy products begins with the milking process and continues until the product is delivered upon the market. A certain minimum in buildings and equipment is required, but even more valuable is the care exercised in the methods.

Milking. Without giving proper attention to the drawing of the milk, milk of high quality can not be produced. There are four important sources of contamination: unclean pails or milking machines, improperly cleaned cows, dirty milking methods, and infection in the udder of the cow.

The proper cleaning of the milking machine has been described previously. The milk pails may be a great source of bacterial contamination to the milk, unless they are properly cleaned and sterilized. Pails that appear clean but that have not been sterilized may contain billions of bacteria which become mixed in the milk as it is drawn. These bacteria in the milking pails are usually of a very undesirable variety that causes putrefactive decomposition in the milk upon standing. To clean the milk pails properly, they should be first thoroughly scrubbed with a stiff brush and a solution of some good washing powder. Next, they should be sterilized preferably by subjecting them to live steam; but, inasmuch as live steam is not available on most farms, scalding the pails with large quantities of boiling water is fairly satisfactory. A number of chemical sterilizers are also quite effective, if used according to the instructions of the manufacturers. It is also important that the milk pails be of the small-topped kind as illustrated in Figure 95. Such pails reduce the possibility that dirt may fall into the milk during the milking.

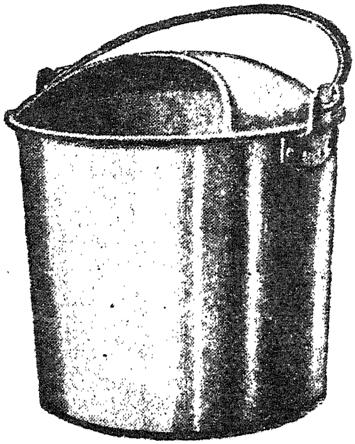


Figure 95. Small top pails should be used to minimize the amount of dirt that may fall into the milk during milking.

Having clean cows is another important step in producing high-quality milk. Keeping cows clean while confined in the barns has been discussed in connection with requisites of a satisfactory barn and the selection of bedding. In addition to taking all the precautions necessary for keeping cows clean, the udders should be washed and wiped dry immediately before milking. Regardless of how clean the barn may be, there is always some dirt on the teats and udder that will fall into the milk during milking, unless the udders are washed. Another great help in keeping cows clean is to clip the flanks, udder, and the underline in the vicinity of the udder.

One of the worst sources of contamination of milk is wet-hand milking. Under no circumstances should anything but dry-hand milking be permitted.

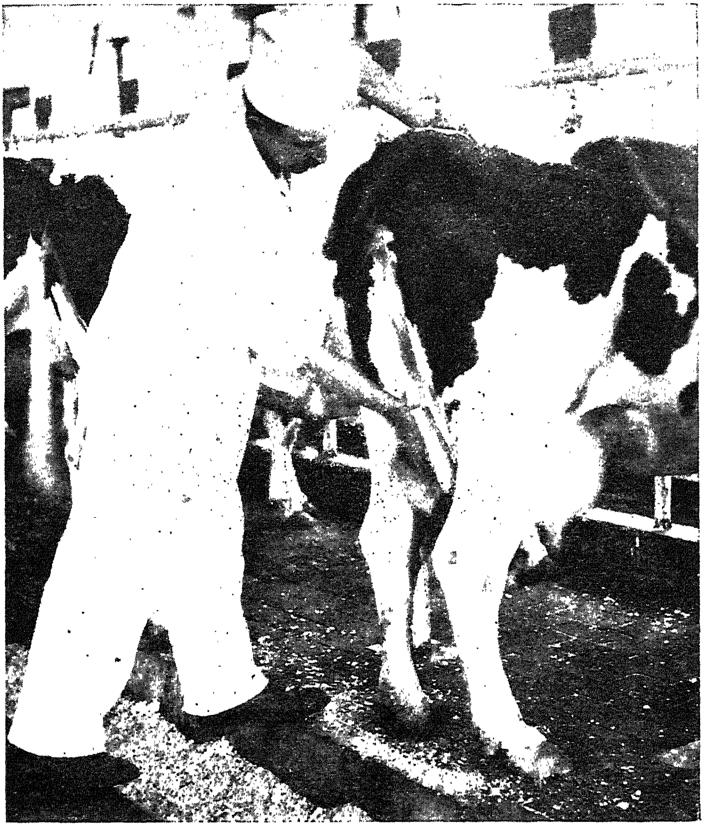


Figure 96. The udders should be washed and wiped dry immediately before milking.

Udder infection is a fourth source of bacterial contamination of milk. When milk has been found to have a high bacterial count and all other sources have been checked, individual cows should be checked for a high bacterial count. It is not uncommon for cows to produce milk with millions of bacteria per cubic centimeter. One gallon of milk, containing a million bacteria per cubic centimeter, will raise the average count in ten gallons by 100,000.

All mastitis milks should be discarded whether or not the bacterial count is high, for such milk lowers the quality of both the milk and the cream. For cheese-making mastitis milk is particularly undesirable, for it lowers both the quality and the yield of the cheese.

Cleaning and Care of the Dairy Equipment. The dairy equipment is one of the most important sources of bacterial contamination of milk. Anything with which milk comes in contact must be thoroughly cleaned and sterilized, if high-quality milk or cream is to be produced. In addition to the milk pails, the equipment includes the strainer, cans, cooler, and separator. If any one of these pieces of equipment is not thoroughly cleaned and sterilized, the milk will become contaminated. In cleaning all these pieces of equipment the same technique should be used as directed for the milk pails. The cleaning, too, should begin immediately after use. First, all pieces should be rinsed with cool water to remove the milk that adheres to the equipment. After sterilization all equipment should be inverted upon a rack for drainage and to prevent recontamination from falling dirt. Bacteria will not develop in dry clean utensils.

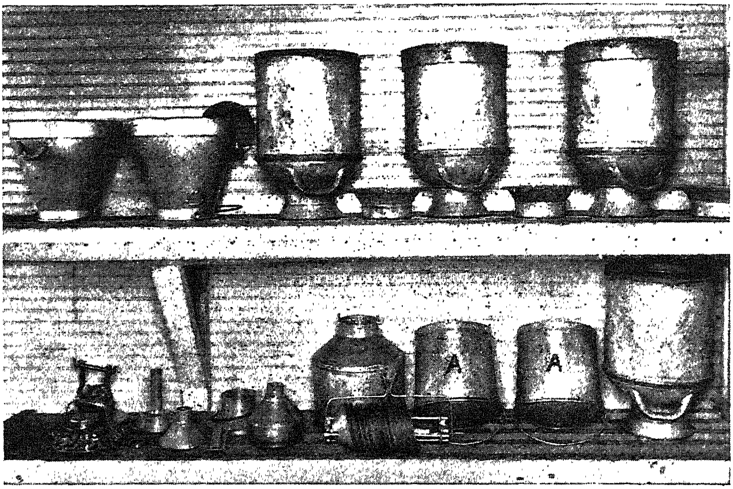


Figure 97. A drying rack upon which the dairy utensils can be inverted and dried.

Cooling Milk. All milk contains some bacteria which multiply rapidly in higher temperatures. The effect of temperature upon the rate of bacterial development is illustrated in Table LI which presents the results of a study in New York.

It will be noted from this Table that bacteria develop rather slowly at a temperature of 50 degrees F. or lower. When the temperature is 60 degrees or higher, the rate of development is increased tremendously. If the bacterial content of milk or cream is to be kept low, then it is imperative that the temperature be reduced to 50 degrees F. or lower. The only other means of avoiding high bacterial content of either milk or cream is to deliver the same to the plant immediately after milking.

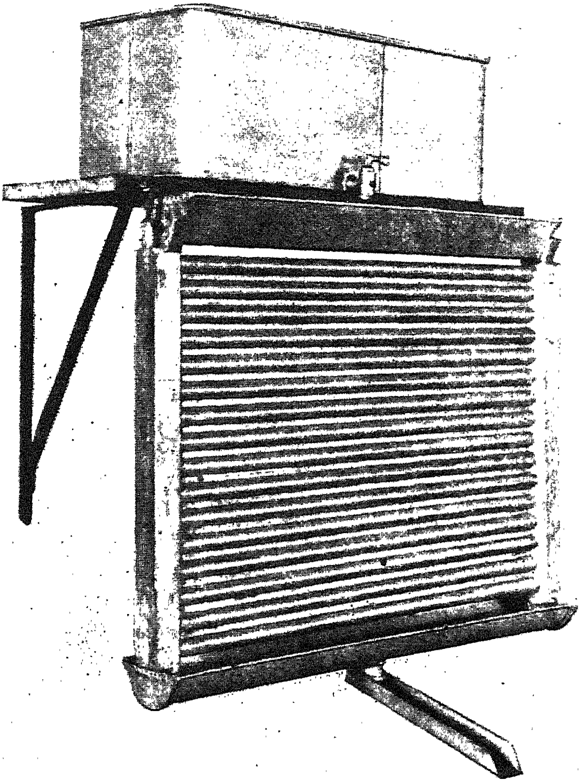


Figure 98. A common type of surface cooler. As a rule, cold water is circulated through the upper coils and cold brine through the lower one half of the coils.

To reduce the temperature of milk quickly, a surface cooler is required. One type of surface cooler is illustrated in Figure 98. The principle is that

TABLE LI—THE EFFECT OF TEMPERATURE UPON THE RATE OF BACTERIAL DEVELOPMENT DURING A PERIOD OF 12 HOURS.

Temperature at Which the Milk Was Kept. Degrees F.	*Bacterial Count per Cubic Centimeter after Standing 12 Hours*
40	4,000
45	9,000
50	18,000
55	38,000
60	453,000
70	8,800,000
80	55,300,000

the milk is permitted to flow in a thin film over the surface of the cooler and cold water flows inside in the upper part of the cooler and for efficient cooling ice water or cold brine is pumped through the lower part of the cooler. There are many types of surface coolers all working upon the same basic principle. The chief objection to them is that the milk is exposed in a thin film to the air and may become contaminated therefrom. Another objection is that they are difficult to clean.

The most common and the cheapest method of cooling milk or cream on the farm is to set the cans in cold water. Where the well water is 50 degrees F. or lower, no other cooling means are necessary for satisfactory results. When the well water is warmer than this degree, ice or artificial refrigeration must be employed if satisfactory quality milk or cream is to be produced. A common and expedient method of cooling, where the well water is cold enough, is to so arrange the milk or cream cooling tank that the water for the stock runs through the cooling tank first, insuring that the temperature be kept low.

Care of the Cream Separator. Space will not permit a detailed discussion of the principles involved in separation, but a few of the more important features will be considered, as an understanding of such is essential for full appreciation of the proper operation of the cream separator. Milk fat is lighter by about 10 per cent than the rest of the milk and will, therefore, rise to the top, if given enough time. The separator rotates the whole milk at different rates of speed according to the percentage of cream which the operator desires to extract. The fat-free milk, as we have just said, is heavier than the fat, or cream. According to the principle of centrifugal force, when matter is rotated, it tends to fly off from the circumference in a tangent. So, if two substances of different weights are in combination, as in whole milk, the heavier will have the greater momentum and, therefore, the greater tendency to fly off; but it is confined by the circle of the bowl, while the lighter cream is naturally forced to the center. Thus we have the fat-free milk in the more distant parts of the bowl and the cream in the center. At the top of the bowl there is what is known as the divider disc, on the inner and lower side of which is the cream and on the outer side of which is the skimmilk. The skimmilk then comes up around the divider disc and reaches the skimmilk opening at the top of the perpendicular center of the bowl. The cream comes out from the cream opening slightly closer to the center of the bowl. Since the pressure increases as the distance from the center of the bowl increases, there is less pressure upon the cream outlet than upon the skimmilk outlet.

The skimmilk and the cream are drawn separately from the bowl through different openings by adjusting the difference in pressure on the cream opening and the skimmilk opening. As the skimmilk opening can not take out all the milk that enters the bowl, a portion must go out through the point where the pressure is lower, that is, the cream opening. By turning the cream screw in toward the center of the bowl the pressure will be reduced on the outflowing cream and less cream with a high test will result. In some machines the adjustment for richness of cream is in the skimmilk opening. Here the cream is made richer by turning the milk screw outward, thus increasing the pressure upon the skimmilk outlet. A greater proportion of the total inlet into the bowl then comes out of this outlet.

Anything that affects the difference in the pressures upon the two outlets from the bowl will affect the richness of the cream and often the efficiency of the separation. Cold milk increases the resistance to the flow of the cream more than the skimmilk and thus a much richer cream results. When the milk is warmer than normal, the opposite effect is noted. Any dirt in either the cream or the skimmilk opening reduces the total capacity of the separator and changes the relative quantities of skimmilk and cream that come out. The richness of the milk that is being separated is a big factor in the richness of the cream. As the separator merely separates the milk into two portions of which one portion contains nearly all the cream, it is to be expected that, when the milk is higher in fat content, the cream from the separator will also be higher.

The speed of the separator is another important factor in both the efficiency of the separator and the richness of the cream. As the pressure of the milk in the bowl is directly proportional to the speed of the bowl, lowering the speed lowers the pressure and, therefore, less efficient separation results. Under reduced speed a larger proportion of the outflow will be through the cream opening and thus the cream will be thinner.

The rate with which the milk comes into the bowl is also an important factor. If the milk flow into the bowl is reduced, then the skimmilk opening will more nearly be able to let out all that comes into the bowl, and there will be a smaller quantity of richer cream. Merely by letting the milk into the bowl at a slow enough rate an ordinary separator may be made to skim cream as rich as 70 or even 80 per cent fat. Some persons take advantage of this possibility and produce the rich cream for home use. The 70 to 80 per cent-fat cream becomes solid when cold. It may be salted and used instead of butter.

The next important factor in running a cream separator efficiently is that it is in good mechanical condition. Any vibration of the machine will tend to prevent the cream from separating from the skimmilk and losses of fat in the skimmilk will result. Dented or bent discs will have the same effect.

The Milk House. While every dairy should have a milk house, the kind of house will depend upon the market requirements and whether cream or milk is to be produced for the market. Space will not permit treating the subject in detail, but merely to deal with some of the fundamental principles involved. The first problem is that of location, which is followed by the general features of such a building.

In order to produce milk for some markets, the milk house must be located not less than 50 feet from the barn. For other markets it may adjoin the barn, provided there is a vestibule between the barn and the milk room. For still other markets there are no requirements. It is obvious, then, that before constructing a milk house the requirements for the particular market must be known. Under any condition it should be so located that it will have good drainage, and that it will be easily accessible to the conveyance for hauling the milk or cream. It is also highly desirable that the house have the advantage of sunlight.

The general plans for milk houses vary also according to the requirements of different markets. In many sections, in order to qualify for the production of market milk, the milk house must have three rooms—one for the boiler, one for the washing of the utensils, and another where the milk is handled. In other areas two rooms suffice, and in others, and generally speaking, where cream is produced for butter production, one room qualifies. Whatever the requirements insofar as the number of rooms may be, there are certain fundamental requirements for a satisfactory milk house. These pertain to the size of the room, a construction that is easy to keep clean, and an arrangement that makes for convenience in performing the work to be done as well as to be properly equipped.

For the production of cream a house 12 feet by 14 feet forms a convenient size for accommodating the necessary equipment and leaving adequate room for work. A floor plan of such a house is given in Figure 99.

It is obvious that the milk house should be kept clean. To facilitate cleaning, the floor should be constructed of concrete and should slope toward a floor drain. It is also desirable that the walls be of concrete plaster. Sufficient window space should be provided, so that as much of the room as possible may be struck by the direct rays of the sun.

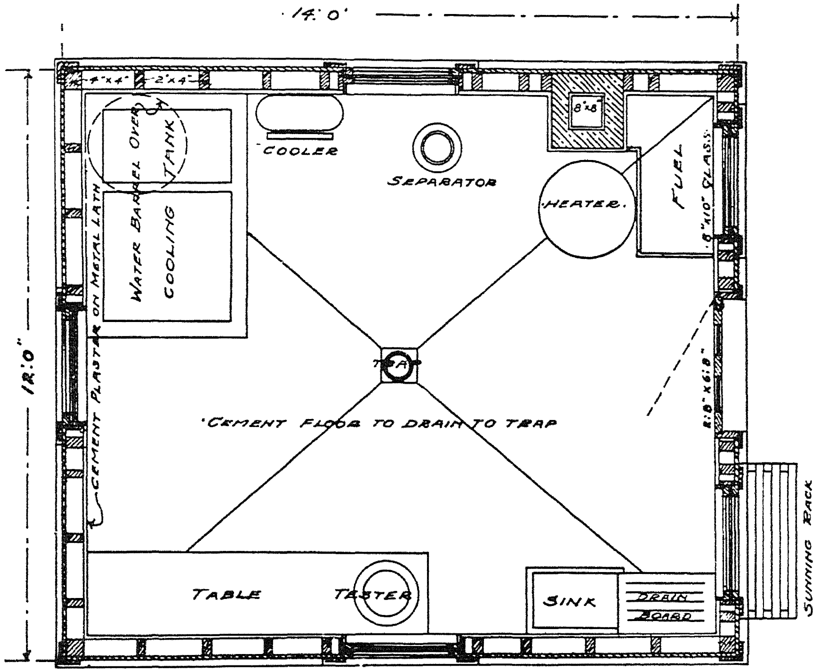


Figure 99. Floor plan of a one-room milk house.

Equipment. The equipment necessary will vary with the size of the herd and as to whether milk or cream is sold. One of the very important pieces of equipment is the wash tank. The wash tank should be of two compartments—one for the wash water with the cleaning powder and the other to contain the rinse water. Each of these compartments should be large enough to permit washing ten-gallon cans with ease. Too small wash tanks and too little wash water contribute materially to a poor wash job. There must also be provision for hot water. The ideal source of hot water is a pressure boiler from which live steam may be gotten for the sterilization of the washed equipment. This equipment, however, is expensive and requires attention to operate. There are many different appliances for supplying hot water in the dairy, including those that are operated by electricity. Many use an ordinary oil stove and a large wash boiler, which, while not as convenient as some other equipment, has the advantage of low cost.

Suggestive Questions

1. What are the most important requirements for satisfactory housing of dairy cows?
2. Why is adequate ventilation of a dairy barn essential?
3. What treatments of feeds for dairy cattle are of value and when are they indicated?
4. What are the fundamental considerations in deciding the ratio of concentrate and roughage that should be fed dairy cattle?
5. Give the reasons that support the statement that pasture improvement is the most important factor in increasing profits from the dairy herd.
6. What are some of the more important factors (aside from housing) that make for comfort for milking cows?
7. Explain why breeding efficiency of cows is of economic importance.
8. Give direction for both the prevention and the treatment of milk fever.
9. Give the reasons why some milkers get more milk from cows than others do.
10. What are the more common afflictions of the udder and the teats and what measures should be taken to prevent them?
11. List the factors (in addition to feed) that affect the production of a cow.
12. In what ways may the composition of milk be changed?
13. List the more common diseases of cattle in the order of importance.
14. What are the important factors in maintaining the herd sire in good serviceable condition?
15. Give directions for producing milk and cream of high quality.

Suggestive Activities

1. Make plans for the remodeling of the barn.
2. Secure the average yields of the different crops and calculate the total digestible nutrients produced per acre of each.
3. On the basis of the results secured from No. 2, make up rations that will produce the largest yield of milk per acre of land.
4. Map the present pasture and lay out plans for its improvement and for adequate supplementary pastures.
5. Construct a model of a safety bull pen with breeding chute.
6. Trim the hoofs of a cow.
7. Secure the bowl assembly of a separator and trace the paths of the incoming milk, the skimmilk, and the cream.
8. Determine the efficiency of skimming of the cream separator by making a Babcock test on the skimmilk.
9. Determine the temperature of the well water.

CHAPTER XXI

MANAGING THE BEEF HERD

Most of the general problems incident to the managing of the beef herd are treated in *Agriculture II.* Many other problems that confront the manager of beef cattle are similar to those that confront the manager of dairy cattle. When beef cows are milked, essentially all the problems of the dairy are met, and, as these have already been treated, reference is made to the chapter on dairy-cattle management. Other problems that are common to both dairy and beef-cattle raising and that have been treated previously are: dehorning, grooming, trimming of feet, disease problems, and several others. There remain, then, for discussion those problems incident to beef production that have not been treated in the previous volumes and that are different from the already treated dairy problems.

The points of greatest difference between dairy-cattle raising and beef-cattle raising are: housing requirements, feeding, feeding equipment, some general management problems, and the product—meat in one case and milk in the other. These beef-raising problems that differ from those of the dairy will be discussed in the order named.

QUARTERS AND EQUIPMENT

Housing. It was shown that milking cows do not need as warm barns as are usually maintained and that the chief reason for the warm dairy barns is to provide more comfort for the workers and not essential for the comfort of the cows. When beef cows are not milked, there is no such need for warmth in the barn. Experiments have shown that low temperatures are not detrimental to heavily-fed beef cattle, but are definitely beneficial. Missouri found that steers on full feed gained more in an open shed than in a barn and still more in an open lot. The gains were also more economical, requiring 11.02, 10.37 and 10.22 pounds of grain, respectively, for each pound of gain.

The important point in furnishing shelter for beef cattle is to provide a place that is dry and free from direct exposure to the cold, wet winds. For the coldest of climates a shed, opening into the lot and providing from 55 to 70 square feet of floor space per animal is adequate. When calves are dropped during the winter, it is necessary to provide warmer quarters for them, as is discussed in *Agriculture II.*

Yards and Lots. The yards and lots for the beef herd are of greater importance than for the dairy, as full-fed cattle are constantly kept in the yards. It is, therefore, of the utmost importance that yards be well drained. In rainy seasons many have been forced to suspend feeding operations because the feed lot became too muddy. The mud, besides making the cattle uncomfortable, becomes the source of serious losses in feed. The hay and grain are trampled into the mud, and, because the hogs can not follow the cattle, there is a great loss of feed.

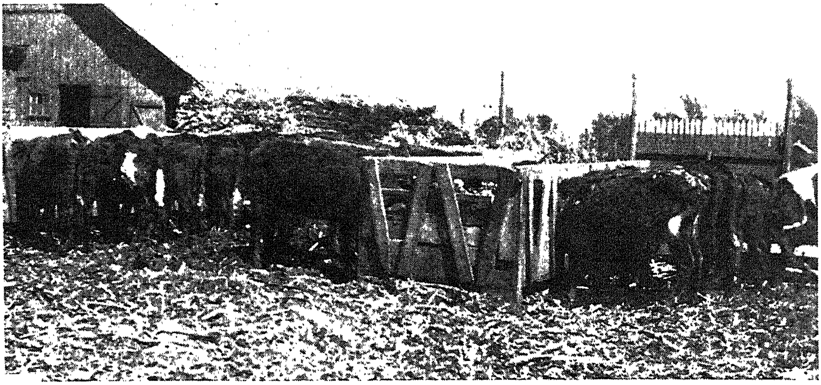


Figure 100. Equipment for beef cattle need not be elaborate or expensive.

Where the feed lot can not be adequately drained, feeding operations should be done only when the lots are frozen or they should be paved with concrete. The feed lot need not contain more than 60 square feet per head of mature cattle or 50 square feet per head of baby beeves.

Feed Lot Equipment. The feed lot should be equipped with a hayrack, feed bunkers, self-feeder, water tank, and salt feeder. Directions for the construction of the self-feeder are given in *Agriculture II*, page 359. This feeder contains several compartments, but the partitions may be removed and the feeder will serve for one grain. The feed bunks should be placed in the yard where cattle can eat from all sides. A good size is 36 inches wide, 26 inches from the floor to the top, and 10 inches high on the sides. The bottom 16 inches from the floor. The length will vary with the circumstances. The bottom and sides should be made from 2-inch plank and the legs from 4″ by 4″ material. For younger cattle the legs may extend into the ground, so as to lower the bunk.

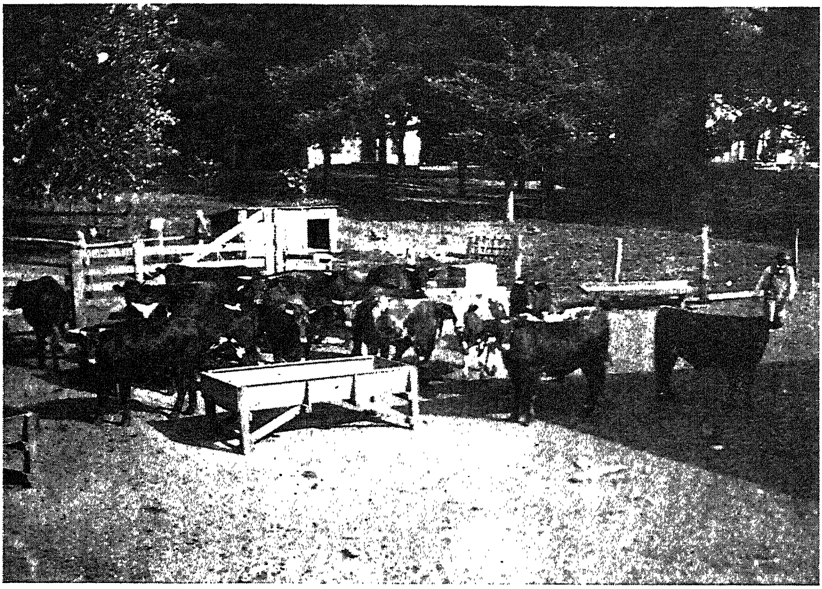


Figure 101. The feed bunk should be of sturdy construction.

To avoid wastage of roughage the hayracks should be so constructed that the animals can not pull out the roughage. The best type and also the easiest to construct consists of a fence of the desired dimensions which is boarded solid from the ground up for 20 inches. Sixteen inches inside this is constructed another fence of railing within which is kept the roughage. The space between the inner fence and the solid wall acts as a manger.

It is important that provision for both salt and water be made. The salt may be furnished in the form of blocks, needing no protection, or in the granulated form which must be protected from the rains. The rack containing the salt may be placed in the shed.

The water is usually most conveniently furnished in a stock tank which may be constructed out of concrete, when it is in a permanent location; but movable tanks of the common metal variety are satisfactory. In cold weather, provision must be made to prevent the water from freezing. A small tank heater will suffice. Banking the tank, so as to prevent excessive loss of the heat to the outside, will also help.

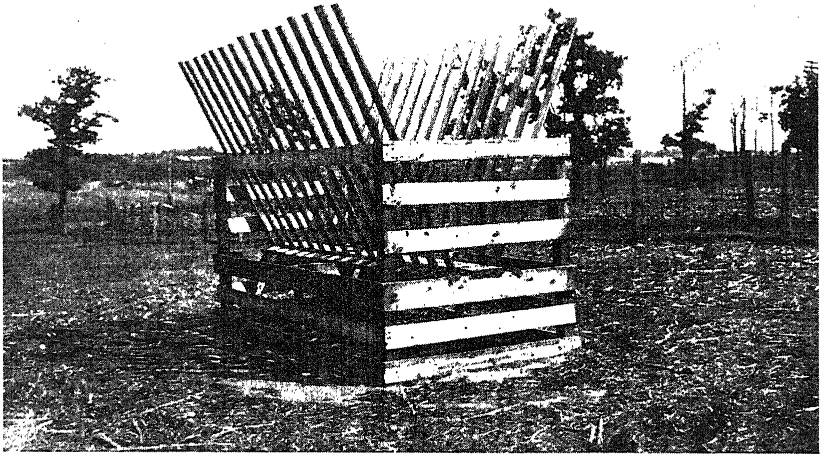


Figure 102. A suitable hayrack for the beef herd lot.

FEEDING THE BEEF CATTLE

In *Agriculture II* the general problems involved in the feeding of the breeding herd, and of the calves and the baby beeves were discussed. Here the problems involved primarily in the feeding of feeder and stocker cattle will be considered. The first problem is a consideration of the requirements for protein and total digestible nutrients, the place of concentrate in the ration, the place of roughage in the ration, and, lastly, factors influencing the ratio of roughage to concentrates.

Fundamental Requirements of Beef Cattle. A knowledge of the nutrient requirements of beef cattle is of as great practical importance as similar knowledge for dairy cattle. The feeding standard for beef cattle, while simpler, is of great value in checking on the adequacy of the ration. The reader is referred to *Feeds and Feeding* by Morrison for the details of the requirements for different sizes of animals. It will be noted that the protein requirement is quite considerable and that, unless the protein in the ration is given consideration, there is likely to be a deficiency of this element. The protein requirements are higher for young, growing animals and decreases with age as the growth rate is lowered.

The total digestible nutrient requirement for fattening cattle is high, a 1,000-pound animal needing as much as 15 pounds for the normal gains expected of animals of that size. The 1,000-pound full-fed animal requires also from 1.6 to 1.8 pounds of digestible protein.

Place of Concentrate in Fattening Cattle. Concentrates serve in the same way in fattening cattle that they do for high-producing dairy cows. In order to secure the fastest gain on the fattening animal, the maximum quantity of nutrient must be consumed. The animal's capacity for bulk is limited. Roughage, containing three quarters of the digestible nutrients of average concentrate mixtures, will not permit sufficient intake to promote the greatest gain. Corn, containing 81 to 82 pounds of total digestible nutrients per 100 pounds, compared to red clover hay with approximately 50 pounds' total digestible nutrients per 100 pounds, contains from 62 to 65 per cent more nutrients per unit.

The second function that is served by concentrates is that, as a rule, they possess greater palatability, and more total poundage of feed is eaten when concentrates supply a goodly part of the ration.

The third function that concentrates serve is to supply additional protein when the roughage is of the low-protein varieties.

For facility in considering the concentrates, they logically divide into two groups—the carbonaceous and the high-protein classes.

The Carbonaceous Concentrates. The most important concentrates for fattening cattle are of the carbonaceous types. They consist of corn, barley, kafir, feterita, oats, wheat, rye, and others. Of these, corn exceeds all the rest in popularity and in efficiency in fattening cattle. By far the most cattle are fattened in the Corn Belt, because of this advantage of corn over other fattening feeds. Corn may be fed as whole corn, ground, or corn-and-cob meal. When the corn is fed whole, it is essential that the cattle be followed by hogs or the loss of nutriment in the manure will be high. When corn is fed as corn and cob meal, the total digestible nutrient content is reduced from 81.5 to 78.1 pounds per 100 pounds and, therefore, more must be fed to secure the same results. The other roughage intake should be reduced. Some prefer corn-and-cob meal to ground corn because it is more bulky and there is less danger that the cattle will go off feed.

Barley ranks next to corn in popularity as a fattening feed. It is less palatable than corn and contains a somewhat less amount of digestible nutrients. In comparative feeding trials barley has been found to be about 90 per cent as efficient as corn in producing gains in cattle.

The sorghum grains, of which kafir, feterita, and milo maize are examples, have very nearly the composition of corn. They are used primarily in the Southwest for fattening cattle. The threshed grain may be ground to resemble ground corn or the heads may be ground to resemble corn-and-cob meal. In most of the feeding trials conducted, the sorghum grains have been proven to be about equal to corn in producing gains on fattening cattle.

Wheat and rye are sometimes used in fattening cattle, when the prices are low or the grain has been damaged so as to be unfit for flour production. In composition both these feeds resemble corn and effect gains approaching those produced by corn. The seeds are hard and must be ground, else heavy losses in the feces will occur. They are not as palatable as corn and have a tendency to form a sticky mass in the mouth. This trouble is overcome to a certain extent, however, by spreading the feed over silage. Before feeding large quantities of rye, it should be ascertained that it is relatively free from ergot, else serious difficulties may be experienced.

Of the high-protein feeds, cottonseed meal, linseed-oil meal, and soybean-oil meal or ground soybeans are the most popular. Peanut-oil meal, corn-gluten feed or meal, tankage, flaxseed, and several medium to high-protein feeds are also used as a source of additional protein. There is no evidence that on the protein basis one is superior to the other. The question as to which one to use is one of price. The one that will give protein or other nutrients at the lowest cost is the one to be used.

The former belief that cottonseed meal is poisonous, when fed in large quantities, has been found not to be true when good hay is fed along with the concentrate. While cottonseed meal formerly contained a poisonous substance known as gossypol, the new method of manufacture has eliminated the danger.

Place of Roughage in the Ration. In the heavy feeding of cattle, roughage usually constitutes a relatively small portion of the ration. It is, however, a very important part. It furnishes a bulk that seems necessary for the well-being of the animal, it is also a cheap source of nutrients and it is the only source of Vitamin D for cattle confined inside during the winter.

Figure 103. Stocker cattle will make good use of low-grade feeds.

Legume hay is, without question, the more desirable of the roughages, although corn or other silages may be used to good advantage. Legume hay is particularly valuable for its high-protein content, three pounds of alfalfa furnishing nearly as much digestible protein as one pound of linseed-oil meal.

The quantity of roughage fed to fattening cattle is dependent upon a number of factors. One of these is the quantity of roughage available. The more roughage available, the larger proportion of the ration it should constitute. A second factor is the relative price of the roughage and the concentrate. When roughage is relatively cheap and concentrates high-priced, it is economical to plan on getting more of the gains from roughage, even though the gains will not be as rapid. A third factor is the length of the feeding period. For long feeding periods it is essential that more roughage be fed to maintain the cattle in good condition. A fourth factor is the stage of the feeding. It is customary to decrease the roughage as the feeding period progresses.

The quantity of roughage used may vary from 4 pounds of roughage to 1 pound of concentrate in the first part of the feeding period, if plenty of roughage is available. In the last part of the feeding period only concentrates may be fed. In a short feeding period of 90 days a representative change in the relation of grain to roughage is from 2 parts of concentrate to 1 of roughage at the beginning of the period and ending with 4 or 5 pounds of concentrate to each pound of roughage. The average ratio for the entire period is about 3 parts of concentrate to 1 of roughage.

In long feeding periods of 180 days or more a representative ratio at the beginning of the feeding period is about equal parts of roughage and concentrate, gradually changing, until at the end of the feeding period the ratio should be about 3 or even 4 parts of concentrate to each part of hay. Under this system, during the entire period, about 3 pounds of concentrate are fed to each 2 pounds of roughage.

If the roughage is plentiful and of high quality, the feeding period may be started with as much as 4 pounds of roughage to 1 pound of grain and then gradually changed until the last finishing stages, when 4 pounds of concentrate may be fed for each pound of roughage. Under this plan during the entire feeding period, about 2 pounds of concentrate will be fed for each 3 pounds of roughage.

Regulating the Quantity of Roughage Fed. The quantity of roughage consumed is regulated by the concentrate allowance. Because of the palatability of the concentrate the cattle will fill up on it unless the quantity is limited. It is customary to feed the roughage, especially the hay, ad libitum, that is, have it before the cattle all the time. The concentrates are then offered in quantities that will secure the desired consumption of the hay or other roughage. It is obvious that, when it is desired to stimulate the consumption of roughage, the self-feeding method can not be used.

The experienced feeder soon learns how much concentrate can be allowed to maintain the desired level of roughage consumption. Once this level is discovered, changing the ratio is very simple. For most of the feeding period, when an additional pound of concentrate is added, there is an equal decrease in the quantity of roughage consumed. Occasionally the roughage may be of such high quality that the cattle will eat sufficient quantities of it to limit the concentrate consumption below the levels desired. In such cases, it becomes necessary to limit the roughage allowance.

Fattening Cattle on Concentrates Alone. It is possible to fatten cattle without any roughage, although it is not advisable to do so unless roughage is not available. When cattle are fattened without roughage the cob should be ground with the corn and ground oats or some other fibrous concentrate should be added. As a rule, cattle on a concentrate alone will not consume as much as when some roughage is added. The rate of gain on the concentrate only is significantly lower than when at least a small amount of hay or silage is included in the ration. Regardless of the cost, some roughage should be included in the ration.

Group vs. Individual Feeding. There is no doubt that the skilled feeder can feed cattle individually so that greater gains can be obtained, but the difference is not sufficient to compensate for the great increase in labor. When large numbers of cattle are fed, they should be divided into groups, according to uniformity in feeding habits, to overcome some of the difficulties encountered in group feeding if there is great variation among the individuals.

Starting Cattle on Feed. One of the important problems in cattle feeding is to start the cattle off right. The way in which cattle are to be started in the feed lot depends to a certain extent upon their previous history. Cattle that have had grain previously can be started off with heavier feeding than those that have never had any concentrate, such as is usually the case with range cattle. Cattle that have never had grain should be fed at starting with but a pound or two the first day and then gradually more up to the full ration. Care must be exercised not to bring them up too fast else they will go off feed.

Off Feed. Whenever cattle are crowded, there is the danger that they may go "off feed." That is, the digestive system is disturbed by being overloaded. The condition is usually accompanied with some putrefactive processes in the digestive tract, and the animal loses its appetite and is not well. To cleanse the digestive tract it is well to administer a physic. Immediately upon noting the condition, the feed allowance should be reduced and then gradually brought up again. As a consequence there is considerable loss in the feeding progress and every precaution should be taken to prevent cattle from going off feed.

Feeding Routine. Except when cattle are on the maximum concentrate they will take, they must have daily attention. When cattle are on the maximum grain, they may be self-fed.

The common practice is to leave hay before the cattle all the time and to feed grain according to whatever the plans may be. While some practice feeding grain, silage, and hay all at the same time and but once daily, this method, nevertheless, is not the best.

As a rule, the cattle should not be disturbed after sunset and before sunrise. It is also desirable that they be through with feeding before darkness. There are many different practices relative to the feeding schedule and no one has been proven superior to the others, except that feeding the grain at least twice during the day is preferable. When grain is fed twice daily a popular feeding schedule is: grain at sunrise, followed with silage; hay an hour or two later; and, finally, grain before darkness. One more grain feeding at noon may be introduced.

FACTORS INFLUENCING BEEF PRODUCTION

The profit that can be made in feeding beef cattle depends upon the cost of producing them and the price received for them. The cost of producing finished cattle is influenced by a number of factors of which the more important ones are: feeding, grade of cattle, age, sex, disease, temperature and kind of finish. Of these the problems involved in feeding have been discussed.

Grade of Cattle. A question that is not settled is that of what type and grade of feeder cattle is going to be the most profitable. Feeder cattle are graded choice, good, medium, and common on the basis of the kind of finished cattle they will make. It is generally agreed that medium and common grades will not finish into animals that will command the highest market price. Those that grade choice and good possess those qualities that, with the proper feeding and care, can be made into a finished product that will command the highest market prices. It is not meant, however, that the latter group is going to prove the most profitable feeders; for, because of their prospects, they command a higher price, and, under some market conditions may leave less of a margin than those of a lower class.

The good feeder is a student of the market conditions. He ascertains insofar as is possible what the probable demand is going to be for the various classes of finished cattle at the time of marketing. On the basis of such calculated probabilities and the relative prices of the different market classes of feeders, he decides what kind to buy.

Effect of Type. For this purpose "type" means conformity to beef standards rather than to breed type. The extremes are the ideal finished beef animal and the dairy type. It is generally agreed that the beef types will finish into a more desirable animal that will command a higher price on the market than the dairy types, although sometimes the dairy types will produce gains at as low or lower cost than some of the beef types. The dairy types are found to dress out into less desirable carcasses. As a rule, the fat is not evenly distributed, there being an undue proportion of kidney fat. The dressing percentage is usually lower and the carcass does not possess the well-rounded appearance that the beef-type carcasses have.

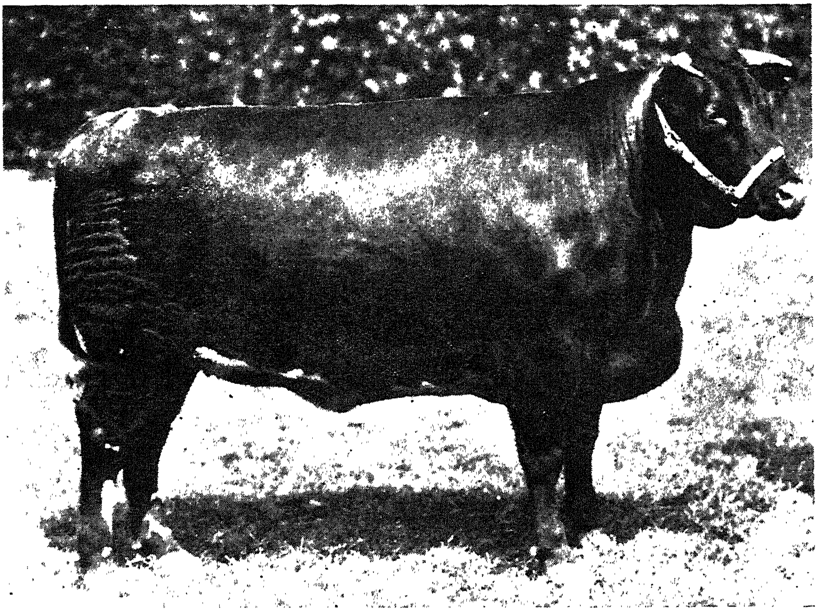


Figure 104. Perfect finish and form command the highest market price.

The Wisconsin Station reported on trials that illustrate the point. Three lots of steers, representing the Angus, crossbred Angus-Holstein, and Holsteins were fed, and the quantity of feed, rate of gain, selling price, and quality of the carcasses were determined. The Holstein steers gained more and at less cost than either of the other two lots. The cost per 100 pounds of gain was $11.20, $13.30, and $12.20 for the Holstein, Holstein-Angus cross, and the Angus, respectively. In the selling value per 100 pounds, the Holsteins ranked far behind, bringing $7.60, while the Angus brought $10.50, and the Angus-Holstein cross brought $10.10. In dressing percentage the Holsteins again were poorest, with a value of 59 per cent, while the other two groups dressed out 62 per cent. The chief reason for the difference in selling price was in the difference in the quality of the carcasses. Only one of the Holsteins graded good and 22 graded medium, while all the Angus graded good or better, and 20 of the 22 Angus-Holstein cross graded good or better.

Age. In *Agriculture II* are given the reasons why the production of baby beeves is so popular and need not be repeated here. Age affects the rate of growth, the rate of gains, the economy of gains, the length of feeding period required, the kind of feed required, and the kind of carcass produced.

How the rate of growth is affected by age of the animal depends upon how the animal was fed up to entering the feed lot. Normally the rate of growth is the greatest the first year, then slowing down by about 25 per cent for the second year, and during the third year the rate of growth is about one third that of the first year, when the animal is in the same condition of flesh all three years. If an animal is heavily fed, as for the production of baby beeves, the combined rate of growth and fattening (total daily gain) decreases with advance in age in proportion to the rates of growth just stated. If, on the other hand, the animal has been kept in only good growing condition and is relatively thin when entering the feeding lot, the rate of daily gain increases with the advance in age up to two-year-olds. Representative daily gains would be 1.9, 2.2, and 2.5 pounds, respectively, for calves, yearlings, and two-year-olds. The reason for the greater daily gains for the older animals is that they have a greater capacity for feed, and, when in a thin condition, can make greater daily deposits of fat.

In economy of gains there is a constant decrease with the advance in age because the animal is larger and an ever-increasing proportion of the total feed intake goes for the maintenance of the body. On the average, about half again as much feed is required to produce a pound of gain on a full-fed mature animal as on a calf weighing 500 pounds.

Effect of Age upon Length of Feeding Period. To partially compensate for the greater cost of the gain, older cattle require less time on full feed to get in prime condition. The length of time required to finish any cattle properly depends upon the condition of the cattle at the beginning of the feeding period. In general, it requires about 20 per cent longer to finish yearlings than two-year-olds and about a third longer to finish calves than yearlings. The reason for the shorter feeding periods for the older animals is explained by the decrease in the rate of growth with the advance in age. For the full-grown animal all the increase in weight is due to the fattening process; while, for the younger animal, a portion of the gain in weight is due to growth, resulting in a slower rate of fattening.

While the increase in weight needed for a satisfactory finish varies greatly for the different classes, the following may be regarded as representative:

Calves	500 pounds
Yearlings	450 pounds
Two-year-olds	400 pounds

Effect of Age upon the Kind of Feed Required. In two ways age affects the kind of feed required. The younger animals require a higher proportion of protein in the ration because they are growing. The younger animals also require a larger proportion of concentrate to the roughage because their digestive tracts will not permit as much bulk as the older animals can handle. When, therefore, there is an abundance of roughage, the two or three-year-old feeder cattle will make a much better use of the feed than calves or even yearlings. As a rule, only about one third of the total dry matter of the ration for calves can be in the form of roughage, while for two and three-year-olds from 45 to 50 per cent, or even more, of the total dry matter may be roughage.

Age and the Efficient Use of Shelled Corn. It is a well-known fact that the younger animals grind their feed better than the older ones. Fattening cattle are no exception to that rule. The common way of measuring the effectiveness with which fattening cattle grind the shelled corn is by the quantity of pork that is produced by the hogs that follow the cattle. The values observed in different experiments vary a great deal, but all point to a greater pork production per bushel of corn fed the older fattening animals. In general, hogs following calves may be expected to produce somewhat less than one pound of pork per bushel of corn fed, while for yearlings each bushel of corn fed should be expected to produce about one pound of pork. For two-year-olds about 1.4 pounds of pork per bushel of corn fed is a fair return.

Effect of Age upon the Quality of Beef. In *Agriculture II* it was shown that the market demands are mainly for the smaller cuts of the baby beeves and, obviously, the older the animal is, the larger will be the various cuts, and, consequently, they will have less favor on the market. With increase in age there is also a tendency for the muscle to become coarser grained, as the enlargement of the muscle with growth is due to an increase in the size of each muscle fiber. Up to two or three-year-olds there is no significant increase in the toughness of the meat; but, when the animals become older, there is a noticeable decrease in tenderness. In animals of advanced age the meat becomes very tough, even if it is in good condition from the standpoint of fatness. With increased age there is a change in the flavor of the meat. To many people the beef from older cattle has a more desirable flavor.

Effect of Sex. While steers constitute the standard feeder, a considerable number of heifers are fattened, and at some time or another the bulls and cows must be fitted for the market. There is considerable prejudice against the heifer as a feeder, particularly in the yearling or two-year-old classes. When fattened as calves, the heifers will make gains comparable to those of steers and will compare favorably with steers in quality and market price. Older heifers are usually pregnant, which condition detracts greatly from the kind of finish that they take, and they are "docked" on the market for the additional losses in dressing due to the fetus they carry.

Bulls are not only harder to fatten than steers, but they also bring a lower price when marketed. The same fact applies to older cows.

The Effect of Disease. While beef cattle are less subject to disease than any other class of farm livestock, occasionally one or more of the various diseases to which cattle are subject breaks out in the feed lot and creates heavy losses. Anything that affects the well-being of the fattening animal will lower the feed consumption and stop gains or even cause a loss of weight. For a general discussion of the diseases of beef cattle, see the discussion in the previous chapter on the diseases of dairy cattle as diseases are common to these two classes of cattle.

Temperatures. Successful full feeding of beef cattle requires cool or cold weather. For this reason most feeding operations are conducted during the colder parts of the year. Heavily-fed cattle develop much excess heat from the digestion of the feed. The heat must be gotten rid of, for in summer it causes real distress. Experiments have shown that the excess heat of digestion is adequate to keep full-fed animals comfortable in temperatures around 0° F. provided they are protected from the wind.

The Kind of Finish. The degree to which cattle finish is an important point in getting the most profit out of them. Frequently cattle are marketed just before they have reached the proper condition, and a lower price is received for them. A few more days might easily, in some cases, raise the selling price, while the additional gain will pay for the extra feed. It is also possible to feed cattle for too long a period, when the gains become low for the feed fed.

CARE OF THE HERD SIRE

The beef sire is sometimes kept in a manner similar to that of the dairy herd sire, when the problems are identical and for such conditions reference is made to the previous chapter where care and management of the dairy bull are treated.

Feeding for Condition. More often, particularly on the range, the herd sire runs on pasture with the regular herd. If so, he is likely to come from the pasture in the fall in a thin condition. As experiments have shown that the good condition of the bull is essential for a good calf crop, it is desirable that he be conditioned before the breeding season begins. For this purpose a good legume hay and oats or a mixture of equal parts of oats and corn is good. The quantity of grain that should be fed will depend upon the condition of the bull and the length of time before the breeding season begins. As a rule, from two to four pounds of grain daily is sufficient. Care should be taken not to get the bull too fat, for too much fat impairs the breeding efficiency as much as too little.

Exercise. As with the dairy bull, the beef bull must have exercise, if his breeding efficiency is to be maintained. The problems in providing exercise for the beef bull are much the same as for the dairy bull, except that the beef bull is not so likely to be vicious and can, therefore, be handled more easily. Some persons make a practice of letting the herd sire run with some pregnant cows during the winter as a means of forcing him to get the required exercise.

Suggestive Questions

1. What are the essentials for satisfactory housing for beef cattle?
2. In what ways are the feeding problems for dairy and beef cattle similar and what are the essential differences?
3. What governs the relative quantities of roughage and concentrate fed fattening cattle?
4. What is the importance of regularity in feeding and caring for the fattening cattle?
5. How does corn compare with other feeds for fattening?
6. What decides when a protein supplement should be fed and what kind?
7. Of what importance is the quality of cattle to be fed?
8. How does age of cattle affect the gains and economy of gains?
9. Why are heifers not always looked upon with favor in the feed lot?
10. Why is cattle feeding practiced during the colder seasons?
11. In what ways does the management of the beef bull differ from that of the dairy bull?

Suggestive Activities

1. On the basis of the roughage and grain available on the farm, ascertain what kind of cattle and how many should be fed.
2. Prepare a plan of the present feed lot, housing, and equipment with suggested alterations for improvement.
3. Determine the quantity of feed needed to increase the weight of a 1,000-pound steer to 1,500 pounds. Do the same for an 800-pound steer.
4. Apply the prevailing feed prices, the cost of the steers, to the conditions in number 3 and, after ascertaining the probable market value of each, calculate the profit.

CHAPTER XXII

MANAGING THE SWINE HERD

The general problems in the feeding and care of the brood sow and the litter, the proper housing, the more common diseases, and the proper sanitation for swine were all treated in *Agriculture II* to which reference should now be made. There still remain many problems for the manager to consider in the proper care and management of the swine herd. Among them are those incident to the feeding and fattening of growing swine, the selection and utilization of feeds, the many factors that affect the quantity and quality of pork, and, lastly, the care and management of the herd boar.

FEEDING SWINE FOR THE MARKET

The feeding of swine presents a number of different situations, depending, to a certain extent, upon the reason for which they are kept. On dairy farms swine are generally kept to utilize the skimmilk, in the Corn Belt they are kept primarily to utilize the corn crop, and in many cases swine are kept merely to produce pork and not with the idea of utilizing any special feeds. As two crops of pigs may be raised a year, the feed problems become different for the two groups. In addition to knowing the fundamentals of each of the foregoing problems, there are the special feed problems that a manager of a swine herd must know, in order to operate the enterprise to the best advantage. Among the special feed problems are: (1) the utilization of garbage, (2) the proper protein supplements, (3) the relative values of various feeds besides corn that are used for swine feeding, (4) utilization of pastures, and (5) other problems of a similar nature.

Feeding Swine Where Corn Is the Chief Feed. Corn leads all other feeds for swine and is truly said to be the basis of the swine industry. Corn alone, however, is an inadequate ration for swine. It shall be the purpose here to consider the supplements to corn that will produce the optimum results.

Corn is the most palatable, and in the Corn Belt the cheapest, feed for swine. When properly supplemented, it will produce the largest and most economical gains. In itself, corn is deficient in several respects. First, it is too low in its protein content; secondly, it is deficient in minerals, and, thirdly, pigs fed on corn alone will suffer from vitamin deficiencies. In addition to being low in protein content, the protein of corn is deficient in some of the essential amino acids and, therefore, is not an efficient source of protein.

Figure 105. Properly finished swine on the way to the market.

In experiments it was found that corn alone as a diet for fattening growing pigs required from 600 to 700 pounds to produce 100 pounds of gain. When the corn is properly supplemented, the total concentrate required per 100 pounds of gain becomes less than 450 pounds.

Supplements to Corn. From the previous discussion it becomes evident that the supplements to corn must provide more protein, minerals, and vitamins. In the summer the cheapest and most efficient means of furnishing most of these requirements is adequate pastures. Pasture will be discussed later in this chapter.

When pasture is not available, the additional requirements must be furnished in some other forms, if satisfactory results are to be attained. For the mineral requirements a mineral mixture should be available at all times. A satisfactory mixture is given on page 383 of *Agriculture II.* This mixture should be kept before swine at all times whether or not they are on pasture, as swine will not consume more minerals than they need.

The additional protein should be supplied from one or preferably more of the protein supplements discussed later in this chapter. The choice of the protein supplement will depend upon the price and availability of the same.

Figure 106. Self-feeding has many advantages.

The vitamins, together with some of the calcium requirement, are best furnished in green alfalfa hay, although any other well-cured and fine-stemmed legume hay is satisfactory. As pigs frequently suffer from Vitamin D deficiency, it is also desirable that they be exposed to the direct rays of the sun as much as possible, even though the weather may be cold.

Yellow vs. White Corn. When swine are on pasture, there is no difference in the feed value between white and yellow corn. In the dry-lot feeding there is a difference in favor of the yellow corn. It is due to the carotene content of the yellow corn which is the precursor of Vitamin A. When white corn is fed more attention must be paid to supplying of green cured alfalfa hay or other sources of vitamin than when yellow corn is fed.

Raising Swine on the Dairy Farm. Swine make excellent use of skimmilk and, therefore, on dairy farms where cream is sold the swine enterprise is generally an important one. Contrasted to where swine are raised to consume the corn crop, on the dairy farm, the swine enterprise should be adjusted to the quantity of skimmilk available. Skimmilk is too bulky as the only feed for swine and has more protein in proportion to the other solids than is needed. Except for very young pigs, one pound of skimmilk or buttermilk for each pound of cereal fed gives the greatest returns. On farms where there is an abundance of milk available, more than the optimum quantities of milk, from the standpoint of increased gains per pound of skimmilk, may be fed with profit.

Skimmilk protein is of the highest value as a supplement to cereal proteins and, when the milk is fed at the rate of one pound for each pound of grain, the protein requirements are adequately taken care of, whatever the grain may be. As a matter of fact, skimmilk has been found superior to any other protein supplement for swine. The mineral content of skimmilk is high and nearly adequate, but it is advisable to keep the mineral mixture before the swine, even if skimmilk is fed in liberal quantities.

Skimmilk or buttermilk is deficient in both Vitamins A and D; so, unless swine are on pasture, additional quantities of these two vitamins must be supplied. Both these vitamins may be supplied by furnishing plenty of green cured legume hay and by exposing the swine to the direct rays of the sun.

The quantities of skimmilk or buttermilk to be fed vary with the quantities available and whether or not the pigs are on pasture. The age and the condition of the swine are also factors that influence the quantities consumed. When the swine are in the dry lot, as has been stated, the optimum gains per pound of skimmilk are secured when the ratio is one pound of milk for each pound of grain. When less than that quantity is fed, some other protein supplement should be added. When milk is plentiful, as much as two pounds of milk may be fed per pound of grain, until the finishing stages, when the quantities of milk must be reduced. During the finishing stages from 4 to 5 pounds of milk per head per day is the optimum.

When the swine are on pasture and corn is fed, 3 pounds of milk per head per day is adequate. If milk is plentiful, as much as 6 or even 8 pounds may be fed per head per day.

Feeding Garbage. In some cases, around large cities hogs are kept primarily to consume garbage, and the problem is to supplement the garbage. The most satisfactory garbage is that which comes from hotels and large eating places, because the quantities are larger and the quality more uniform. Garbage collected from homes varies a great deal from day to day and also frequently contains material that will be injurious to the hogs. The composition of garbage varies greatly. On the average, it requires about two and one half tons of garbage to produce 100 pounds of gain. Many garbage feeders raise the hogs on nothing but garbage, others feed garbage to supply about half of the nutrients required and furnish corn or some other cereal to supply the other half.

Garbage produces pork of as high quality as most other feeds. The losses from garbage feeding are frequently high, due to contamination with material such as broken glass, table and kitchen utensils, and other objectionable materials.

Other Cereal Grains Fed Swine. While corn is by far the most popular feed for swine, it is by no means the only one fed. Barley, oats, grain sorghums, wheat, and rye are also used to a greater or less extent.

Barley. While barley will produce only about 90 per cent as much gain for the same quantity of feed that corn will, barley has some advantages over corn. It produces a firmer fat and, therefore, a more desirable bacon. Barley also contains somewhat more protein and, therefore, a little less of the protein supplement need be fed. Whenever barley is fed, it should, because of the hard hull, be ground or soaked, else large losses in undigested material will result.

Hull-less barley has a higher feeding value than the ordinary varieties, being about equal to corn in producing gains. Whenever barley is fed, care should be taken that it be relatively free from barley scab. When more than about 10 per cent of the barley is affected with scab, the palatability is reduced and the hogs will be made ill.

Oats. Oats are too bulky as the only grain for swine. This grain, however, can be used to advantage when limited to 25 or 30 per cent of the grain. When corn is not properly supplemented with high protein feeds, the addition of oats to the ration greatly increases the rate of gains and reduces the quantity of grain needed per 100 pounds of gain. Whenever oats are fed, they should be ground to medium fineness. Soaking apparently does not improve the digestibility of oats.

Several experiments have been conducted where hulled oats were fed. While the value of hulled oats for swine feeding is much higher than for the whole oats, the cost is so great as to make them prohibitive. When oats form any appreciable part of the ration, the fat becomes soft and, therefore, is undesirable.

Grain Sorghums. The grain sorghums, of which milo, kafir, feterita, and darso are the more common, form an important part of the fattening rations of swine in the southwestern part of the country. The grain sorghums are a little superior to barley and not quite as good as corn for fattening swine.

As the grain sorghums have about the same composition as corn, they also have the same deficiencies. The supplements to grain sorghums should be the same as for corn.

While the sorghum seeds are harder than corn, there is no particular advantage in grinding or soaking them.

Wheat. Wheat is fed to swine only when the prices are very low or when it has been damaged so as to be unfit for milling purposes. Normal wheat has a feeding value for swine that is equal to, or slightly better than, that of corn. As wheat is a little higher in protein content than corn, a little less protein supplement is needed. Several trials have reported excellent results with wheat as the sole grain when pigs are on pasture. Experiments also indicate that there is little to be gained by grinding wheat, when it is fed in self-feeders.

Rye. When the market price of rye is low, this grain is often fed to swine, and sometimes with disastrous results. Rye that is contaminated with considerable ergot should never be fed to swine, except in small quantities. In some experiments there have been poor results with rye that was free from ergot. In other experiments rye was found equal to corn, when properly supplemented, in producing gains.

On the basis of the varied results reported when rye is fed to swine, it is to be advised not to feed rye as the only grain to swine for any length of time. When rye is available, unless it is definitely known that larger quantities are not harmful, not over one half of the grain should consist of this cereal. As with wheat, there is little to be gained by grinding.

PROTEIN SUPPLEMENTS

One of the most common deficiencies in feeding swine is that of furnishing insufficient protein, particularly in the Corn Belt where skimmilk is not available. The problem for the feeder of swine is to choose the protein supplement that is the cheapest and that will supplement the ration in the best possible manner. As a great many different protein supplements are used in different sections and under different conditions different supplements are indicated, it is desirable to consider the features of the more common high-protein feedstuffs suitable for swine feeding.

Of the protein supplements skimmilk and buttermilk have been considered previously, but there remain many more animal and plant products that are suitable for this purpose in swine feeding. Among the animal products are: tankage, meat scraps, fishmeal, and whey. Among the more common plant protein supplements are: linseed meal, soybeans, soybean-oil meal, cottonseed meal, peanuts, peanut-oil meal, high protein corn by-products, and wheat by-products. In addition, there is the problem of mixtures for the protein supplement.

Animal Products. In general, animal products including skimmilk and buttermilk are more efficient sources of protein than the plant sources. With prices and availability the same, the animal sources of the protein supplement are, therefore, to be preferred.

Tankage. Tankage has for a long time been a favorite protein supplement with swine feeders for all classes of swine. High-grade tankage contains more than 60 per cent protein, which is the usual minimum guarantee. The protein in tankage is of the highest quality and has a high supplemental value to the grain proteins. Tankage also is high in its content of calcium and phosphorus and, therefore, supplements grains in this respect also. Like skimmilk, tankage is deficient in the essential Vitamins A and D which must be supplied from some other source.

Tankages of lower grades are also on the market where the protein content may be as low as 30 or 35 per cent. As all tankage is sold with the minimum protein content guaranteed, this commodity should always be bought on the basis of its protein content.

While tankage may be fed as the sole protein supplement with good results, better results are obtained when a high-protein plant product is fed with it. The quantities to be fed will vary with the size of the pigs, the other grains fed, and whether or not the pigs are on pasture. When pigs are under 100 pounds and are not on pasture and the grain is corn, 10 per cent tankage and 5 per cent of one of the high-protein plant supplements is a standard mixture. Under the same conditions, unless the pigs weigh over 100 pounds, only 5 per cent of tankage and the same quantity of a high-protein plant supplement is adequate. If the grain is barley, wheat, or rye, each of the protein supplements for all conditions may be reduced 40 per cent.

When pigs are on pasture, one half of each of the protein supplements required for the dry-lot feeding is adequate for each of the weight classes and the grain specified above.

Meat Scraps. Meat scraps or dry-rendered tankage is comparable in all respects to the ordinary tankage, except that the protein content is somewhat lower, usually 55 per cent for the higher grades. To furnish the same quantity of protein about 10 per cent more must be fed of the dry-rendered than of the ordinary tankage, and then more digestible nutrients other than protein is fed from this source. The other grains may then be reduced proportionately.

Fish Meal. Fish meals, like tankages, vary in their protein content and, therefore, must be purchased upon the basis of the protein content. The highest grades contain over 63 per cent protein, while lower grades may contain as little as 50 per cent. In the many trials that have been conducted, comparing the feed value of fish meal and tankage, it has been found that the fish meals are equal, if not slightly superior, to tankages of comparable quality. It may, therefore, be used in the ration in the same quantities as comparable qualities of tankage.

While most fish meals will not flavor the pork, when large quantities are fed of the grades that are high in fat, the pork will partake of a fishy flavor. There is little danger from this difficulty, if the quantities fed are kept down to the level that is just necessary to supply the needed protein.

Whey. Whey can not be said to be a high-protein supplement in swine feeding, as the protein content of average whey is about 0.9 per cent. The protein of whey, however, is of such high quality in supplementing the cereal proteins that it must be regarded as a protein supplement. Whey is used extensively in the cheese-producing areas as a hog feed, and, when the grain is barley or wheat, some excellent results have been secured without any other supplements than all the whey the hogs would consume. Experiments comparing whey with skimmilk found whey to be worth about one half as much as skimmilk.

Plant Protein Supplements. Plant protein supplements are used extensively in the feeding of swine either as the sole source of the protein supplement or in combination with animal products. As a rule, the plant proteins are not as efficient in supplementing the grain proteins as the animal proteins are. This deficiency, however, is often compensated for by the lower prices for the plant protein. The same results can frequently be secured by feeding a larger quantity of the plant protein supplements and at even a lower cost.

Linseed Meals. Linseed meal, as the sole source of the protein supplement, is not very efficient, particularly for pigs weighing under 100 pounds and not on pasture. When the pigs approach 200 pounds in weight, linseed meal is a fairly good protein supplement; but, even here, it is not advisable to restrict the protein supplement to this one source, unless the animal protein feeds are very much higher in price.

Linseed meal serves best in combination with any one of the animal-protein supplements, increasing the efficiency of them all. Equal parts of linseed meal and tankage or fish meal have a higher supplementary value than either fish meal or tankage. When skimmilk or buttermilk is insufficient in quantity to supply the needed protein, an addition of linseed meal is very effective.

Soybeans. Soybeans have been gaining in popularity as a supplement for swine because of the large increase in soybean production and because by using soybeans the protein supplement can be homegrown. While the protein of soybeans is superior to the protein of linseed-oil meal and is a good supplement to corn, there are several objectionable features to this supplement.

The first objection to soybeans is that, because of their high oil content, the pork becomes soft and is unpopular on the market, if the beans are fed in quantities adequate to furnish the needed protein. Packers are now paying lower prices for swine from the soybean areas because of the lowered values of the soft pork produced from soybeans. The second objection is that the raw soybeans are not very well digested by swine. Only after the soybeans are cooked are they well digested. Extra work is required and the desirability of the supplement is lessened. Like linseed meal and other plant supplements, soybeans are deficient in minerals and vitamins.

The soft pork effects of soybeans may be overcome to a certain extent in one of two ways. One half of the soybeans may be replaced by tankage, meat scraps, or fish meal, and the efficiency somewhat increased, or, for the last seventy or more days of the feeding period, the soybeans may be omitted entirely, and the pork will be greatly improved.

Soybean-Oil Meal. Soybean-oil meal, which is the residue after the oil has been extracted, is a far more satisfactory protein supplement than the natural soybean. If the meal has been heated in the extraction process, the digestibility is good and such meal may be used as the sole protein supplement with satisfactory results. About 10 per cent more soybean-oil meal is needed than tankage.

The value of soybean-oil meal is increased when some tankage or animal protein is also included. Often the soybean-oil meal is so palatable that it can not be fed by the self-feeder method, because the hogs may eat more than is required.

Cottonseed Meal. In the South and several other areas, cottonseed meal is the cheapest source of protein. The protein of cottonseed meal supplements the proteins of the cereals somewhat better than the protein of linseed meal, yet, for two reasons, it is not advisable to feed cottonseed meal as the sole source of the protein supplement. First, the efficiency of the cottonseed meal is greatly increased if any one of the animal proteins is also present, and, secondly, there is danger of poisoning from feeding too much cottonseed meal. Cottonseed meal contains a toxic substance known as gossypol to which swine are quite susceptible. If cottonseed meal is kept down to less than 10 per cent of the total ration, there is no danger from the poisonous effects.

To compensate for the danger from the poisoning by gossypol, cottonseed meal has a very beneficial effect upon the character of the pork. When fed as a supplement to corn, it materially increases the hardness of the pork, which is a very desirable characteristic.

While cottonseed is a good source of phosphorus, it is deficient in calcium and in Vitamins A and D.

Peanuts. Peanuts are used extensively in the peanut-growing territories in the growing and fattening of hogs. Large acreages are grown solely for the feeding of hogs that are turned in to harvest them. This method of using the crop is known as "hogging down." Peanuts, vines, and nuts rank as the most efficient of all feeds in producing gains in swine. A hundred pounds of gain have been reported on less than 200 pounds of peanuts.

The chief objection to the feeding of peanuts is that they produce a very soft pork. Packers generally deduct about $1.00 per hundredweight on hogs that come from peanut feeding areas. Aside from the softening effect, there is no other detrimental effect of peanuts upon the quality of the pork.

Peanut-Oil Meal. Peanut-oil meal may be used as the only protein supplement; but, like cottonseed meal, its efficiency is increased when accompanied by any of the animal proteins. The peanut-oil meal does not produce soft pork when fed in the quantities necessary to supply the protein needs. Peanut-oil meal is deficient in minerals and vitamins which should be provided from other sources.

Corn By-products. In the manufacture of cornstarch and other products there are several by-products that are high in their protein contents. The three most common of these products are: corn-gluten feed, corn-gluten meal, and corn-oil meal. Although these feeds are excellent sources of protein for dairy cattle, they are not advised as protein supplements for swine feeding. The reason for not looking upon these feeds with favor is that the proteins are poor supplements to the proteins of the cereals and, particularly, to corn.

Wheat By-products. Among the wheat by-products standard middlings, red-dog flour, wheat-flour middlings and bran are fed to swine. Of these wheat bran is poorly adapted to swine feeding because of the high fiber content. Only in the case of brood sows should wheat bran be regarded as a feed for swine and then only limited quantities should be fed.

Standard middlings have long been a favored feed for swine not because of their high protein content, for middlings contain but 15 per cent of protein, but because of their high supplemental value to other feeds. Middlings are sometimes used as the only feed in fattening hogs, plus, of course, mineral and vitamin supplements. But to use middlings alone is not advisable unless they are considerably lower-priced than corn; for middlings are somewhat less efficient in producing gains than corn. When swine are on pasture, middlings have greatest value when combined with corn or other grains. When swine are fed in the dry lot, middlings are most valuable in combination with animal protein such as skimmilk, fish meal, or tankage. Middlings are high in phosphorus but lacking in calcium and vitamins.

Wheat-flour middlings are lower in fiber content than standard middlings and are, therefore, of greater value for the feeding of young pigs. The wheat-flour middlings are usually too high-priced as feeds for fattening hogs. Red-dog flour is still lower in fiber content and proportionally of higher value for feeding young pigs. As with the wheat middlings, vitamins and minerals, particularly calcium, must be furnished in addition.

Mixtures of Protein Supplement. In the discussion of each of the protein supplements it has been repeatedly stressed that the efficiency of each one is increased when fed with some other. In general, the plant and animal proteins supplement each other. It has also been shown that all the protein supplements are deficient in Vitamins A and D and that, unless the pigs are on pasture, these vitamins must be supplied from some other source. And, *again, all the plant protein supplements are deficient in* calcium and most of them are deficient in phosphorus.

It is obvious that, to supply the protein and vitamin requirements in one mixture of the highest efficiency, would be very desirable. As a result of work done at the Wisconsin Experiment Station, such a mixture was developed and known as the "Wisconsin Mixture" or the "Trinity Mixture." This mixture consists of 50 pounds tankage, 25 pounds linseed meal, and 25 pounds ground alfalfa hay.

In the trinity mixture tankage and linseed meal furnish proteins that supplement one another and the cereal proteins. Tankage furnishes liberal quantities of both phosphorus and calcium, and the linseed meal is also a good source of phosphorus. The alfalfa hay is the source of additional calcium and protein and of Vitamins A and D. It is important that the alfalfa be of high quality and of green color, as only such hay will contain enough Vitamin A.

Since the advent of the trinity mixture, many experiments have been conducted, testing out the values of various substitutes. In general, it has been found that fish meal and meat scraps may replace the tankage. Cottonseed meal, soybean-oil meal and peanut-oil meal may replace the linseed meal. Any good legume hay, such as clover, lespedeza, or soybean hay may replace alfalfa hay.

PASTURE FOR SWINE

While swine are not adapted to the utilization of roughage, no other class of farm animals will bring larger returns per unit of pasture than swine, provided the pasture is of the right kind and that it is properly supplemented. In many trials it has been shown that pigs on good pasture make more rapid gains on less grain and protein supplements than those in the dry lot.

The reason for the rapid and economical gains may be briefly summarized as follows: Pasture grass is palatable to swine and, being much lower in fiber than hay, a considerable portion of the nutrients is secured therefrom. Young pasture grass is high in protein content, thus sparing on the amounts of protein supplements that need be fed. Green pasture grass is one of the richest sources of carotene, which is the precursor of the much needed Vitamin A. While on pasture, the pigs get the needed exercise, and, while green grass does not contain Vitamin D, the exposure of the pigs to the sun, while on pasture, produces adequate quantities of this vitamin.

Figure 107. Good pasture is essential for rapid and economical gains.

Pasture Crops. Many different kinds of pasture are used for swine. The kind that is best for any particular farm depends upon the character of the farm and the kind of pasture that is available and will do the best. The advantages and disadvantages of the more commonly used pastures for swine will be briefly discussed.

Alfalfa. Alfalfa is the best all-around pasture for swine and wherever this plant can be grown successfully it should be given serious consideration for the swine pasture. Alfalfa, if properly managed, excels in its palatability, nutritive value, and the fact that it furnishes good green pasture during the entire season. Another advantage is that alfalfa is a perennial and, therefore, unlike some of the pasture crops, need not be seeded annually. In pasturing alfalfa it is important that it be not grazed too heavily. As a rule, not more than 20 pigs should be grazed per acre and the excess growth cut for hay.

Red Clover. Red clover ranks next to alfalfa as a pasture for swine. Alsike clover is practically of the same value as that of red clover, and white clover is fine in a pasture mixture. The clovers usually yield less than alfalfa and, therefore, can not be grazed as heavily. Usually 15 pigs per acre is the limit for the best results. As with alfalfa, the clovers should be mowed for hay at the proper times so that the growth does not become too mature and thus greatly reduce its value.

Sweet Clover. Sweet clover may be used for hog pastures, but is not as desirable as either alfalfa or the clovers. The feed value is as great, provided swine will eat sweet clover as well; but, as a rule, it is not palatable. Often, when swine are first turned on sweet clover, they refuse it altogether. In most cases, however, they will develop a fair liking for it. Sweet clover pastures should be managed in the same manner as alfalfa pastures.

Rape. Rape is a very popular pasture that in experiments has been found to be very nearly of the same value as alfalfa in the production of pork. The chief disadvantage of rape is that it must be seeded annually. To offset this disadvantage rape is resistant to light frosts and may be pastured later in the fall than other pastures. Rape pasture has about the same carrying capacity as that of alfalfa; but, if pastured too close, will be greatly damaged. When there is less than an average of five leaves to the plant the rate of growth is slowed up. Thus when grazed down below this point, the swine should be removed to permit recuperation.

Rape pasture is reputed to cause sunscalding of white pigs, and sometimes of thin-haired pigs with pigmented skins. Pigs on rape should be watched for the appearance of blisters, and, when any are found, the blistered area should be rubbed with a heavy oil or vaseline.

Frequently peas, oats, and other grains may be seeded with rape to give variety and increase the palatability of the pasture.

Soybean Pasture. With the growing popularity of soybeans in the Central States there is an increasing interest in soybeans for swine pasture. The green immature soybean is a good swine pasture, ranking with the legumes in this respect. The chief objection to soybean pasture is that it is of too short duration, as it is late in starting. Cowpeas and velvet beans in the South have the same value as soybeans.

The Grasses and Permanent Pasture. Bluegrass and other grasses in mixed permanent pastures furnish good pasture for swine when green and immature; but, as these plants get older, the fiber content increases and the protein decreases, which, together with the lower palatability, reduces the pasture values materially. When the mixed grass pastures are managed, so as to keep young growing grass at all times, such pastures are satisfactory.

One advantage for permanent pastures is that the work involved in seeding each year or periodically is avoided. This advantage, however, is offset by the increased danger from round worms, which topic has been discussed in *Agriculture II.*

Other Pastures. Any crop that furnishes pasture for other classes of livestock may be used for swine pasture. Two need special mention because of the fact that they sometimes fit into any pasture scheme. These are winter wheat and winter rye. Either one of these two crops in the North may produce good pasture late in the fall after other pastures are gone and then again furnish good pasture in the spring before other pastures are available.

Methods of Feeding Swine. Two general methods are used in feeding swine. One is known as "hand feeding" and the other is known as the "self-feeder" method. As each one has its place, a brief consideration of the two methods and their relative merits is in order.

Self-Feeding. No other farm animal exercises as good judgment in balancing a ration when given a chance, as the pig. Because of this fact and that it is generally the most profitable to grow pigs as rapidly as possible, the method of self-feeding hogs has become very popular because it saves considerably on labor. The method is equally applicable to swine on pasture and in the dry lot.

When the self-feeder is used, the grain and the supplements are generally placed in separate hoppers and the pigs may eat as much as they want of any of the feeds. As there are many advantages to having the protein supplement made up of several different ingredients, such as the trinity mixture, it is customary to have but three compartments in the self-feeder—one containing the corn or whatever grain is to be fed, another containing the trinity mixture or whatever modification of it that may be necessary, the third containing the mineral mixture.

Many experiments set up to test the comparative values of the self-feeder method with hand feeding have shown that hogs will make as economical gains by the self-feeder method as by the best hand feeding.

Hand Feeding. While self-feeding produces as good gains with less labor than hand feeding, there are conditions where hand feeding is necessary. One of the most important situations where hand feeding must be practiced is in feeding the brood sow—a problem that was dealt with in *Agriculture II*. A second situation, when it becomes necessary to hand feed at least in part, is where one of the feeds is not palatable and the quantities of the more palatable feed must be limited. A good example of this situation is where roasted soybeans are fed as the protein supplement. Roasted soybeans are so palatable that the pigs will eat more than they should at the expense of the grain.

A third situation where hand feeding becomes necessary is when it is decided to make greater use of pasture by limiting the grain and protein supplement. When plenty of pasture is available, by limiting the grain, more of the pasture grass will be consumed. While the rate of growth is slowed down, there are conditions where this method will produce pork more economically.

FACTORS INFLUENCING PORK PRODUCTION

There are many factors that influence in one way or another the production of pork and with which the person in charge of swine must be familiar, if he is to produce most economically. Among the more important problems of that kind are: the size and vigor of the litter, the relation of size to the rate of growth, when to market hogs, full feeding vs. limited feeding, various treatments of the feed, bacon vs. lard types, barrows vs. sows, factors affecting the quality of pork and the effect of crossbreeding.

Size of the Litter. The first problem in economical pork production is to insure large litters per sow. The total cost of keeping a sow must be distributed to the cost of the pigs at weaning time. As the cost of keeping a sow is no small item, the smaller the litter, the greater will be the individual cost per pig, and, conversely, the larger the litter, the lower will be the cost per pig. Some of the factors involved in the production of large litters are hereditary in nature, and, therefore, can be insured only by careful selection of the breeding stock. Another factor is that of proper feeding before breeding.

Of even greater importance is the problem of saving the pigs that are born, as the economical production of pork demands that a large number of pigs per sow reach the market. The problem of avoiding losses of young pigs is treated in *Agriculture II* under Care and Management of Young Pigs.

The Relation of Size and Rate of Gain. To know the effect of the size of a pig on the rate of gain will enable one to form a better idea as to when the most economical gains are made and will help in governing the feeding operations. Table LII, taken from reports from the Ohio Experiment Station, illustrates the whole story.

Figure 108. The object in swine feeding achieved. A lot of uniform finished pigs ready to be marketed in six months.

TABLE LII—The Daily Gains and the Feed Required per Hundred Pounds for Pigs of Different Sizes

Weight of Pigs	*Daily Feed*	*Daily Gain*	*Feed per 100 Pounds Gain*
Lbs.	*Lbs.*	*Lbs.*	*Lbs.*
Birth to 100	2.2	0.81	304
100 to 200	6.1	1.70	359
200 to 300	7.6	1.83	415
300 to 400	7.8	1.71	470
400 to 500	8.0	1.58	510

From this Table it will be seen that the daily feed consumption per head rose with the increase in weight, but not proportionately. The daily gains rose with increased size up to the 300-pound group and from there decreased. The most significant fact, however, is that the quantity of feed required to produce 100 pounds of gain increases with each weight increment.

When to Market Hogs. From the facts revealed in Table LII it would appear that the younger and smaller hogs are marketed the more economically. It will be noted, however, that the feed requirement per 100 pounds gain for a 200-pound pig is not much greater than for the 100-pound group. This fact, and because the market demands are for hogs weighing from 200 to 225 pounds, make the most desirable weight slightly over 200 pounds.

Full Feeding vs. Limited Feeding. Other things being equal, the more rapidly the desired weight is reached the less will be the costs. Since the rapidity of gain is proportional to the daily consumption of feed, full-feeding is to be preferred to limited feeding. Putting the problem more specifically, when hogs are to be fattened upon corn and the proper protein supplement, there can be no question that full feeding is the most economical. This kind of feeding is accomplished by the self-feeder method, as directed previously.

Limited feeding is to be considered only when large quantities of cheap but utilizable feeds are available and of which the pigs can not consume enough to make the maximum gains. The best example of this situation is, that, where plenty of pasture is available, cheaper gains can be made, even though the rate of gain be slow.

Various Treatments of Feed. Questions that naturally arise in the feeding of swine pertain to the advisability of grinding, soaking, cooking, and whether or not the feed should be fed in a slop.

Grinding. Pigs do a pretty good job of grinding most of the feeds they receive, particularly if they are fed in self-feeders, where more time for eating is afforded. Sometimes in hand feeding, because the pigs are hungry, the feed is swallowed before it is properly chewed. In general, it never pays to grind corn. It usually pays to grind oats and barley, whether fed by hand or the self-feeder. Other moderately hard seeds, such as the grain sorghums, wheat, and rye, need not be ground if fed in the self-feeder, but it often pays to grind them when fed by hand.

Soaking. Soaking has the same effect upon digestibility that grinding has, and, when practiced, should be done for the same reason. It merely softens the seeds, so that they are better chewed and thereby better digested. It usually entails more labor than grinding and presents a problem in sanitation. Grains should never be soaked long enough to ferment; for, by so doing, there is a loss in nutrients and there is the possibility of causing digestive disturbances.

Cooking. Cooking feeds for swine has been practiced by many, entailing a lot of work and cost in fuel. Experiments have definitely proved that, instead of increasing, cooking reduces the digestibility of feeds, particularly the protein fraction. Two important exceptions to the rule are potatoes and soybeans, the digestibility of which is increased by cooking.

Slop Feeding. Many people believe that pigs do better when their feed is mixed into a slop. Instead of proving this theory true, experiments have shown that there is an advantage in feeding the grains and supplements in the dry form and furnishing the water separately. When finely ground feeds are fed in the open, there may be a large loss from the wind. Under such circumstances, it will pay to mix the feed in slop.

Bacon vs. Lard Hog. Hogs fall into two distinct types, one known as the bacon type and the other as the lard type. The bacon type has never become very popular in this country, very largely because corn is the principal hog feed and the prices for superior bacon types have not been high enough to induce swine raisers to grow the bacon types. A few have developed a special market for the choice bacon that can be produced only by the bacon type. The bacon on the American market is mainly from the lard type. The better grades of bacon are selected from the sides of hogs that carry considerable lean meat and a firm fat.

Barrows Compared with Gilts. It is commonly believed that barrows are superior to gilts in the gains that they make and the quality of the dressed carcass. Careful observations, however, reveal that the difference is very slight. The barrows seem to gain slightly faster than the gilts, but the gilts have a slightly higher dressing percentage. In the colored breeds the bacon from gilts that are sexually mature may have dark particles, known as seeds, in the region of the mammary glands.

Factors Affecting the Quality of Pork. The quality of pork is influenced by the inheritance of the pig and the feeds fed. Inheritance has much to do with the relative distribution of lean and fat. The difference between the lard and bacon types is a good example of the effect of inheritance upon the quality of pork.

Feed effects are quite varied. One effect is of quantity. As the pig gets fatter, the proportion of lean to fat decreases. The most pronounced effect of feed upon the character of the pork is that upon the hardness of the fat. As has been indicated, several feeds produce what is known as soft pork, that is, pork where the fat is softer than normal. This condition is very undesirable, as the cut surface of bacon or other cuts is greasy. Soybeans and peanuts are the two most commonly used feeds that produce soft pork. Corn, although not recognized as producing soft pork, produces pork of only moderate hardness as compared with barley. When feeds producing soft pork are fed, the bad effects may be partially overcome by omitting the offending feed for some time before the hogs are marketed. For soybeans, about 70 days are required to satisfactorily overcome the softened condition of the fat.

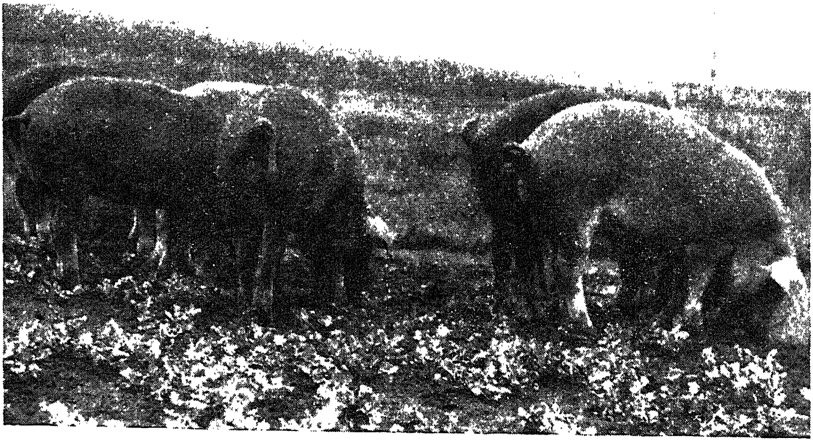


Figure 109. A group of pigs resulting from the use of a Duroc Jersey boar on Poland China-Duroc Jersey sows.

Not much work has been done on the flavor-producing effects of feeds upon pork. It is known, however, that certain feeds produce undesirable flavors in the pork. Fish meal that is high in its fat content will produce a fishy-flavored pork. Onions and garlic, when included in the ration regularly, will also flavor the pork.

Crossbred Swine. In recent years, experiments have shown advantages of crossbreeding swine. Two general methods of crossbreeding are practiced. One is when boars of two breeds are alternated and the other when the boars of three breeds are rotated. One of the prime essentials for success in a crossbreeding program is the use of purebred boars. The crossbred sows are said to be equal or superior to the purebred mothers.

The advantages of crossbreeding are given as larger litters, stronger pigs with fewer losses, larger pigs at weaning time, faster-growing pigs and less feed required per 100 pounds of gain.

The Minnesota Station reports that at weaning time crossbred pigs averaged from two thirds of one to two more pigs per litter that weighed from 5 to 7 pounds more per pig. The crossbreds required from 17 to 22 days less to reach the marketing weight of 220 pounds and required from 27 to 36 pounds of grain less than comparable purebreds.

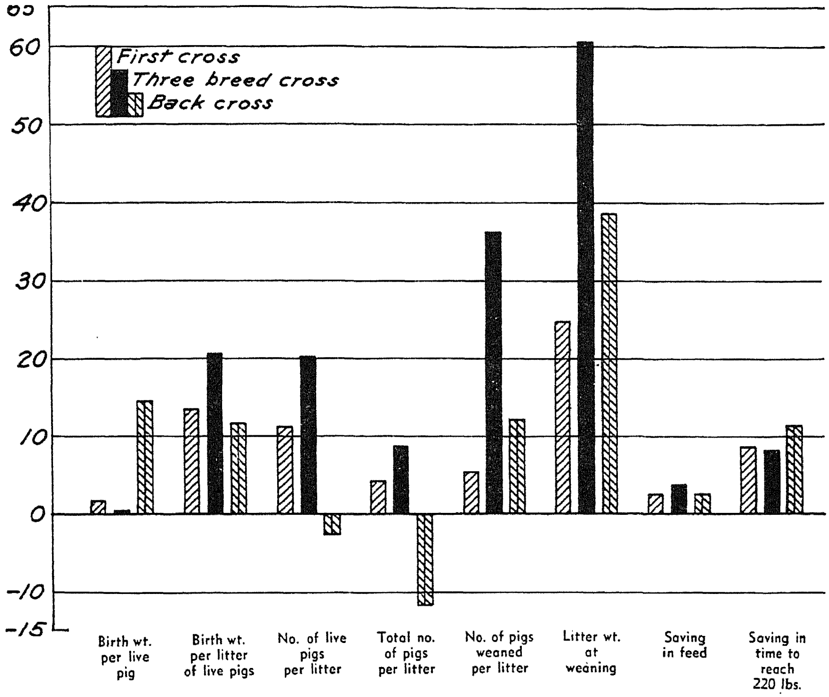


Figure 110. Percentage superiority of the three groups of crossbreds over comparable purebreds.

Hogging Down Corn and Cereals. The term "hogging down" or "hogging off" refers to the practice of turning swine into a field of either corn or other crops to harvest them. Corn ranks first as a crop for hogging down, followed by peanuts, the grain sorghums, soybeans, and cereal crops.

The chief arguments for the hogging down practice are that the cost of harvesting the crop is saved, and that, when the corn or other crop is lodged, there is less loss to the crop. Experiments have shown that there is little difference in gains from hogging down and dry-lot feeding, when both methods are properly supplemented. In case of wet seasons there are likely to be considerable crop losses, due to the tramping. In many cases this loss will offset any saving that is made in harvesting costs.

One of the chief objections to the hogging off practice, in addition to that just mentioned, is that the method can be practiced for only a short time. For corn, the crop is usually not sufficiently mature to begin the practice before the first of October, and the weather is usually too severe after the first of November. If the crop is peanuts, the period is also short, but for a different reason. After they have reached the proper stage for hogging off, only about a month intervenes before the nuts start to sprout and the practice must be stopped.

CARE AND MANAGEMENT OF THE BOAR

Care and management of the boar is important to the extent that it improves the breeding efficiency of the herd. He is often fed and cared for in such a manner that his breeding efficiency is greatly impaired, resulting in delay in the breeding of the sows or even in their failure to become pregnant. The losses incurred under such management are obvious.

It has been shown that, to have boars with breeding efficiency, they must first be properly grown and be in the proper condition during the breeding season, and, lastly, they must be properly managed during the breeding season.

Development of the Boar. The object in growing the boar is similar to that of growing the breeding gilts—to get the maximum growth and maintain the greatest possible health and vigor. To accomplish this aim, the growing boar should be kept in fair condition and given plenty of exercise. The feeding and management practices that give the best results are identical with those discussed for the development of the breeding gilts in *Agriculture II,* page 374. It is again emphasized that plenty of pasture is an essential for the best development of the growing boar. It furnishes valuable nutrients for growth, including vitamins, and is the best means of securing the necessary exercise.

Preparing for the Breeding Season. During the off breeding seasons, the boar should be kept in a vigorous condition, but not fat. Just before the breeding season the quantity of feed should be increased, so that he gains in weight, but care should be taken that he does not become fat, for fat slows up his breeding powers. As the boar should be hand-fed, in order to regulate the amount of feed consumed, the requirements are most conveniently supplied in one mixture. There are many mixtures that will serve the purpose equally. The mixture to be used depends upon the available feeds and their cost. It should contain a liberal quantity of protein supplement and not over 50 per cent corn. A reasonable quantity of bulk in the form of oats is also desirable. Wherever skimmilk is available, the following ration is a good one:

Ground corn	50 pounds
Ground oats	30 pounds
Middlings	20 pounds

Skimmilk 15 to 25 pounds daily and free access to the mineral mixture and salt, as well as pasture or high-quality alfalfa.

When skimmilk is not available, 10 pounds of tankage should be substituted for 10 pounds of corn, to make the ration satisfactory. Although it is highly desirable that the ration should contain some animal feeds, plant protein supplements may be used.

Management of the Boar During the Breeding Season. After seeing that the boar is properly fed during the breeding season, he must not lack exercise nor be used excessively. While boars have bred as many as three sows daily on several successive days, it is believed that such a practice is detrimental to the future efficiency of the boar. Two services a day for a strong vigorous boar, however, are regarded as practical. If there are two services, they should be spaced as far apart during the day as possible and not more than one service per sow should be permitted. If a sow is in heat on the day following a service, a second service is indicated.

Suggestive Questions

1. Compare the problems involved where swine are kept for the utilization of the corn produced and where they are kept to utilize the skimmilk.
2. For swine what are the common sources of Vitamin A? Vitamin D?
3. Compare the relative merits of protein supplements from plant and animal sources.
4. What are the main problems in garbage feeding?
5. What are the causes of soft pork and how may this defect be partially overcome?
6. What are arguments in favor of a protein supplement mixture, such as the trinity mixture?
7. What are the relative merits of the different pastures for swine?
8. Compare the relative merits of self-feeding and hand feeding.
9. How does the size of the litter affect the efficiency of pork production?
10. What factors contribute to 200 to 225 pounds live weight as being the best weight to market pigs?

11. What are the conditions when limited feeding of market pigs is economical?
12. Under what conditions should the feed be ground? Soaked? Cooked?
13. How may the quality of pork be affected?
14. In what ways does crossbreeding contribute to more economical pork production?
15. For the care and management of the boar, give directions that will produce the best results.

Suggestive Activities

1. From a record of the quantity of milk produced, determine the number of pigs that should be kept to make the optimum use of the skimmilk.
2. Secure the most available protein supplements and make up a satisfactory mixture of the nature of the Trinity Mixture.
3. Make plans of a self-feeder, and if possible, construct one.
4. Find the cost of producing 100 pounds of live weight in pigs, using current prices.

CHAPTER XXIII

MANAGEMENT OF SHEEP

In *Agriculture II* the general problems considered pertaining to the feeding and care of the breeding and pregnant ewes are: (1) problems at lambing time, (2) the feeding and care of the growing lamb, and (3) the more common parasites and diseases affecting sheep. There are still many problems to be considered relating to the raising of sheep. Among these problems are: (1) the housing and equipment necessary for sheep-raising, (2) further consideration of the feeding involving the relative values of the different feeds for sheep, (3) the special problems in the fattening of lambs and sheep, (4) factors affecting the production of mutton and wool, and (5) care and management of the ram.

HOUSING AND EQUIPMENT

While the housing and equipment requirements for sheep are small, there are certain minimum needs for efficient and successful sheep-raising. These include the needed buildings for the protection of the sheep against the elements, the necessary yards and pens, feeding equipment and proper fencing.

Housing. Sheep require less protection against cold than any other farm animals. Their heavy coats of wool furnish excellent protection against the coldest weather, provided they are dry. As a matter of fact, there is more of a problem in having the barns too warm than too cold, because in too warm an environment sheep will perspire and then suffer when exposed to the cold.

In the coldest of climates the only shelter that is necessary is a roof and a single thickness of boards that will keep out the winds and furnish a dry bed. The next important consideration is that the shed should furnish not less than 12 square feet of floor space for small sheep and 18 square feet for larger sheep. Less space will cause crowding that is detrimental, particularly to pregnant ewes. The shed should be well ventilated to prevent the accumulation of moisture, which is harmful to sheep. While sheep have an excellent protective coat of wool, this coat also holds much moisture, which produces chills when the sheep are exposed to wind and cold.

Equipment. Provisions need be made for the feeding of grain and roughage. Troughs for the grain or silage and racks will be required for the hay. A mature sheep will need from

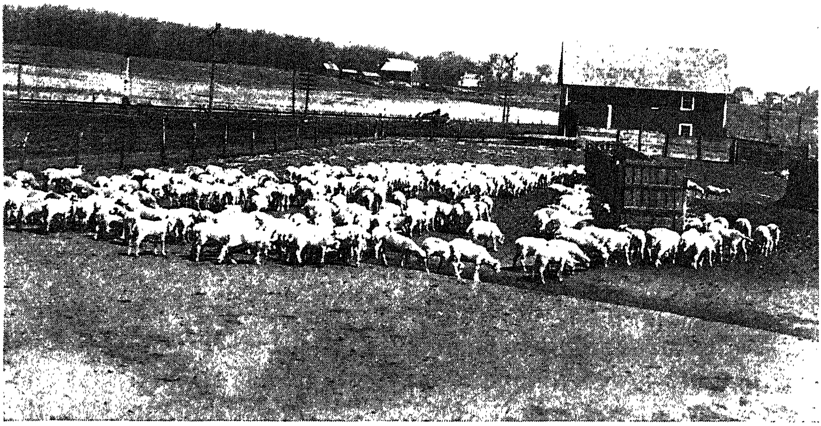


Figure 111. Lambs in the feed lot require but little equipment.

16 to 18 inches of trough and hayrack space. Fattening lambs need about 20 per cent less.

The troughs should be but four inches deep, but should be wide, so that the grain may be scattered to prevent too fast eating. The hayrack should have perpendicular slats to prevent particles of hay from falling upon the wool about the neck and shoulders. Many prefer to have the hayracks and feed troughs combined. If these are combined, the trough should be about 12 inches wide and the hayrack should form the inner side. The trough then serves also to collect the leaves and particles that drop from the hay when pulled through the hayrack.

Care should be taken to avoid sharp corners or protruding parts in all constructions with which the sheep may come in contact, for such prominences will cause injury to the skin and serve to catch wool from the passing sheep. It is also essential that the doors or gates be wide enough to permit two sheep to pass through at the same time. It is the habit of sheep to crowd when let out through a gate or door, and, if the openings are too narrow, considerable injury may result.

In fencing for sheep, two points must be borne in mind. First, the fence must be adequate to retain the sheep, and, next, it should be smooth, to avoid catching wool when the sheep brush against it. Not only may large quantities of wool be lost on barbed fences, but considerable injury is also inflicted upon the skin of the sheep.

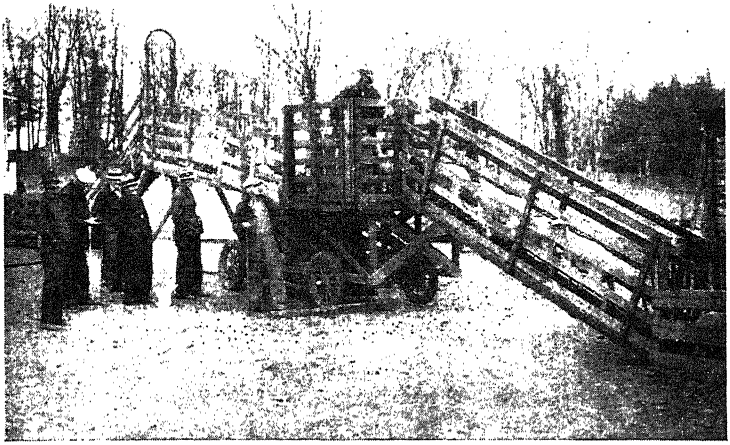


Figure 112. A portable outfit for dipping sheep.

FEEDING SHEEP

While the principles underlying the feeding of the breeding flock and the growing lambs have been considered in *Agriculture II*, there still remain many problems in relation to the feeding of sheep.

Fattening. The problem relating to the fattening of sheep must be considered. It includes the relative values of the different feeds and the methods used in fattening sheep. The fattening of sheep is a fairly extensive industry. As most of the sheep are raised upon the range where grains for fattening are not available, the range sheep are shipped into the Midwest, principally the Corn Belt, for fattening. As users of corn, sheep rank with cattle. That is, for fattening they need about the same proportions of concentrate and roughage as cattle.

The feeds for fattening sheep may be divided into the following groups: roughage, concentrates, and roots. The roughage is of two kinds—the dry roughage and the silages. The concentrates fall into two groups—the carbonaceous and the protein supplements.

Nutrient Requirements of Sheep. Sheep, being ruminants, utilize and digest both concentrates and roughage the same as cattle. Full-fed fattening sheep, however, take from 15 to 20 per cent more of digestible nutrients per 100 pounds of liveweight than cattle. According to the Morrison Standard, fattening lambs weighing 50 pounds need 0.16 to 0.19 pound digestible protein and 1.2 to 1.5 pounds of total digestible nutrients daily. At 100-pound weights they need 0.25 to 0.27 pound digestible protein and 2.0 to 2.3 pounds total digestible nutrients daily. Thus, not only more total digestible nutrients, but, also, a relatively higher proportion of digestible protein is needed per pound of liveweight at the 50-pound than at the 100-pound liveweight levels.

Carbonaceous Concentrates. Corn ranks first as a concentrate for fattening sheep. It is followed by barley, the grain sorghums, oats, wheat, and several other feeds.

Corn. In the fattening of cattle and swine, corn ranks first. In the Corn Belt it is the cheapest of all concentrates and the most abundant. It is one of the most palatable of all feeds for sheep, and, when properly supplemented, will produce the greatest gains.

Corn is deficient in protein and must be fed with a liberal quantity of high-quality legume or be supplemented with some high-protein feed. The fact that corn is deficient in carotene is relatively unimportant in the feeding of sheep, as the hays are usually adequate sources of carotene. When the roughage is of the low-protein varieties, it becomes desirable to furnish additional calcium, when corn is fed. The additional calcium may be furnished in the form of bone meal or ground limestone.

Barley. Barley is a very satisfactory feed for fattening sheep, as it is capable of producing as rapid gains as corn, but requiring somewhat more grain per pound of gain. In a large number of experiments, where corn has been compared with barley, it has been found that barley has about 87 per cent the value of corn in producing gains.

Because it has a little higher protein content, barley does not need as much protein supplement, when the roughage is of the low-protein varieties. It has the same deficiency in calcium that corn has, and for fattening growing lambs should be supplemented with calcium, unless a legume hay is fed.

Because barley is a little more bulky, it is not so likely to put sheep off-feed, when fed heavily, as corn is.

The Grain Sorghums. The grain sorghums are the chief fattening feeds in the Southwest. Many experiments have shown that, pound for pound, the threshed grain sorghums are equal to corn in fattening sheep. The composition of the grain sorghums and corn is nearly identical in all respects, so that the problems involved in feeding these grains are identical with those encountered when corn is fed.

Oats. Oats are too bulky to give the best results, when fed alone to fattening sheep. Oats are palatable and very valuable as the sole grain for breeding flocks. For fattening sheep they are very useful in starting a flock on feed and again serve as a means of lightening up the corn mixture when sheep are self-fed. When oats are the only grain, they are worth about 85 per cent as much as equal quantities of corn in producing gains. When used in limited amounts in a mixture, oats may be worth as much as corn.

Oats, having a somewhat higher protein content than corn, require less protein supplement with low-protein roughages.

Wheat. Wheat is not often sufficiently low in price to be used as a feed for sheep; but, when it is, it has a value about equal to that of barley. Wheat has a tendency to form sticky masses in the mouths of sheep and is also more likely to put sheep off-feed. For these reasons the best results are obtained when wheat is mixed with other feeds, of which oats and barley are among the best.

On account of its low protein content, wheat gives the best results when fed in conjunction with a legume hay.

Rye. Rye ranks with wheat as a feed for fattening sheep. It is more palatable to sheep than to other classes of animals, and, if low-priced enough, may be used in the same manner as wheat.

Molasses. Molasses is used in sheep feeding, both as a fattening agent and as a means of improving the palatability of some otherwise unpalatable feeds. Both beet and cane molasses have been used, and, if they have the same sugar content, there is no difference between the two in feeding value. When molasses is used, not more than one half a pound should be fed daily. When fed at this level, molasses has the same value as corn.

Molasses may be fed by pouring a ribbon in the feeding trough or may be mixed thoroughly with either the grain or the roughage. When the roughage is used for this purpose, it must be cut. One of the chief objections to the feeding of molasses is the danger of getting some on the wool of the sheep.

Protein Supplements. When low-protein roughages are fed in conjunction with the carbonaceous grains, additional protein must be furnished for good results in the fattening of sheep. Among the protein supplements used, linseed meal and cottonseed meal lead. Soybeans, wheat bran, and corn-gluten meal or feed are also frequently used. In the protein supplements there is no evidence that any one has any superiority over any other one, when considered upon a comparable basis. The choice of the protein supplement should, therefore, rest upon the basis of the lowest cost of the needed additional protein.

When linseed meal or cottonseed meal is fed, not more than 0.12 to 0.15 of a pound will be needed to supply the needed protein. Under similar conditions, 0.25 to 0.35 of a pound of wheat bran is needed.

Besides the protein feeds listed, any other protein feed that is used for cattle-feeding may be used to supply the needed proteins in sheep-feeding. The quantities of any protein feed needed to satisfy the requirement for any ration can easily be ascertained by determining what the needs of the sheep are and how much the ration without the supplement supplies. The protein supplements should be mixed with the grain mixture.

Dry Roughages. Sheep, like cattle, are especially adapted to use roughage, and, even at the height of the fattening period, roughage must constitute a substantial part of the total ration, else disastrous results will ensue. While sheep can make good use of relatively low-quality roughage, the better the quality of the roughage, the greater use may be made of it, and, as a rule, cheaper gains will be made. The roughages are naturally divided into two classes—the leguminous and the nonleguminous kinds.

Legumes. In fattening sheep, the legumes are much to be preferred to the nonlegumes. The reasons are that well-cured legumes are more palatable than other kinds, have a higher protein content, and are higher in calcium. The fact that legumes are more palatable enables one to make greater use of roughage a considerable factor in economic mutton production. As the quantity of grain usually should not exceed the quantity of roughage by very much, in order to prevent the sheep from going off-feed, it is also evident that, when hays are palatable, more grain can also be fed with safety.

The high-protein content of the legumes is probably even more important than the palatability factor. High-quality legume hay will furnish all the protein required, even with corn as the only grain. As high-protein supplements are usually the most expensive constituents of a ration, it is evident that legumes can reduce feeding costs.

While calcium supplements, such as ground limestone or even bone meal, are relatively inexpensive, the high-calcium content of the legumes must be listed as a favorable characteristic. When legumes are fed, the ration is adequate in calcium and the inconvenience of furnishing calcium supplement is avoided.

While all the legumes possess the same general characteristics, that is, palatability, high protein, and high calcium, alfalfa is, as a rule, superior to all other legumes in these respects and is the most commonly used in the fattening of sheep. Red and alsike clovers that are well cured and of fine stems rank close to alfalfa in feed value. Sweet clover and soybean and cowpea hays are of value in direct proportion to the quality of the hay. Often the three latter-mentioned hays are coarse and stemmy, and, therefore, their feeding value for fattening sheep is considerably reduced.

Nonlegume Hay. The nonleguminous roughages consist of the grass hays, fodders from corn, and the sorghums and straws. While there are variations in the composition of these roughages, they are characterized by low-protein and low-calcium contents. As a rule, these feeds also lack in palatability, although early-cut and well-cured grass hays and fodders may be very palatable. Whenever the nonleguminous roughages are fed and the grain is also of the low-protein kinds, protein supplements must be furnished for satisfactory results. The marsh hays, corn stover, and the straws are neither palatable nor nutritious and are also constipating. Such feeds, therefore, should be used only if better hays are not available.

Mixed Hays. Mixed clover and timothy hay are common on many farms, and, if cut early and cured well, such hays are fairly satisfactory for sheep. While the protein content of the mixed hay is higher than that of the nonleguminous roughages, it is still too low, without additional supplements, to satisfy the requirements for fattening sheep. Additional calcium is also advisable.

Silage. Most authorities believe that silage adds materially to the ration of fattening sheep. Experiments have shown that, when approximately equal parts of alfalfa hay and corn silage were fed, better results were secured than when the roughage was alfalfa hay alone. Here the corn silage furnished only about one third as many digestible nutrients as the hay. The improvement in the results is attributed to the appetizing effect of the silage as well as to the slightly laxative effect.

In experiments where corn silage was the only roughage, the results were not so encouraging. Corn and sorghum silages are deficient in protein, calcium, and Vitamin A, in all which substances legume hays are high. As a rule, equal parts, by weight, of silage and legume hay are to be preferred.

Grass silages, such as those made from the grasses and legumes, are even better than corn or sorghum silages for sheep. These silages are higher in protein, and, if preserved with acid or molasses, are also rich in Vitamin A. If the silage is made from legumes, it will have about one third to one fourth the value of the hay.

Roots. Roots may take the place of silage in the ration when about 4 or 5 pounds may be fed daily per head. On an average, it takes one and one half pounds of roots to equal one pound of corn silage. Roots may be fed at much higher levels. In Great Britain, in fact, lambs are often fattened on roots fed in quantities ranging up to 20 pounds per head daily.

Mangels, rutabagas, turnips, and beets are the most commonly fed roots. Beet pulp, either wet or dry, is often fed to sheep with good results.

Pasture. As with cattle, pasture is the cheapest and best source of succulent feed, provided it is adequate in quantity. For the breeding flock no other feed is needed, when pasture is available. For the fattening lambs, pasture is a very desirable source of all roughage. Most of the feeding operations, however, are carried out after the pasture season is ended.

The pastures may be either permanent or temporary. The permanent pastures are frequently not luxuriant enough for the best results in fattening lambs. Clovers or rape, or peas and oats pastures are also frequent. For fattening sheep, rather than let them run over the entire pasture, small portions should be fenced off to be used in rotation. Sheep are even more subject to bloat than cattle are, and, when on a legume or rape pasture, they must be watched. When an animal appears to be bloated, it may often be relieved by the administration of half an ounce of formalin in a pint of water given as a drench.

Treatment of Feeds. Sheep are excellent grinders of their feed and prefer the grains whole rather than ground. Experiments have shown that grinding corn for sheep renders it slightly less digestible. Grain should be ground only when it is fed in a mixture of the roughage. Under such conditions, unless it is ground, a fairly stable mixture can not be expected.

Likewise, grinding or cutting of the roughage does not increase either the palatability or the digestibility. Only when the stems of the roughage are refused is it advisable to cut the roughage. When the roughage is cut in fairly short lengths, the sheep are not able to select portions and refuse them. When grain and roughage are to be mixed, cutting of the roughage is essential to facilitate mixing.

There is no evidence that cooking the feed for sheep increases its feeding value.

Methods of Feeding Sheep. It is important not only to know the kinds of feed that will make sheep feeding profitable but one must also know how to feed them. In fattening sheep, the problem is to feed them as much as they will consume without going off feed. To do so requires skill. As most feeder sheep are shipped some distance before the feeding process begins, there is the problem of starting them on feed. Next is the problem of getting them on full feed. In addition to these problems, we must know how much a sheep should be fed, the order in which the different feeds should be given, the relative difference between self-feeding and hand feeding, and how long the feeding period should be.

Starting Sheep on Feed. When the sheep to be fattened are raised locally, they may be started right in on the fattening ration, with the grain limited to about one half pound and the roughage given ad libitum. When the sheep have been shipped from some distance and especially from the range, they are both hungry and thirsty and not accustomed to the feeds. Extreme care must be exercised in starting them off on feed. First, their thirst should be satisfied by giving them limited quantities of water over a period of several hours. They should be furnished all the hay they will eat, but the grain should be limited to from one fifth to one fourth pound per head. Sheep may be started upon corn alone, but it is preferable to start them on a mixture of equal parts of oats and corn or oats and barley.

The grain should be spread out thinly in the manger or upon the ground, to prevent too fast eating. The quantity of grain may be gradually increased and the oats gradually eliminated, unless it is to be fed during the feeding period. At the end of the second week, the grain should be up to twice what it was at the beginning. The quantities should then be gradually increased until the sheep are on full feed.

Order of Feeding. Sheep should be fed twice daily. The grain should be fed first in such quantity that can be consumed in a few minutes. It should be followed immediately by the silage or other succulence that may be fed, and then the hay is fed preferably in excess. When the hay is not limited, the sheep will fill up on it. As the grain allowance is increased, the quantity of hay consumed will decline.

Quantity to Feed. The quantity of grain and roughage to feed depends upon the size of the sheep at the beginning of the feeding and the length of the feeding period. A 60-pound lamb, during the first week of feeding, will usually eat about 1.7 pounds of hay, when the grain allowance is 0.2 of a pound. As the feeding period advances and the grain allowance is increased, the hay consumption decreases, so that, in the seventh week of feeding, the quantities of grain and roughage are equal. A representative ration at this time would be about 1.2 pounds of each, hay and grain. As feeding continues and there are further increases in the grain allowance, there is still further decline in the quantities of hay consumed. At the end of the feeding period there may be twice as much grain fed as hay or dry matter in the roughage, if both hay and silage are fed. Variations from these ratios are to be expected. They serve only as typical examples.

Self-feeding Sheep. When large numbers of sheep are to be fed, many prefer to self-feed them in order to save on labor. In self-feeding it will not do to feed a grain like corn ad libitum, as too much will be eaten and heavy losses from digestive disturbances are likely to result. Two methods are used to avoid this danger. One is to mix the grain with about 20 per cent of light bulky feeds, such as oats, bran, or ground alfalfa hay. The other is to grind the hay and grain together in the proportions that they ought to be fed and feed the mixture ad libitum. When the latter method is practiced, it becomes necessary to change the proportions of grain to roughage as the feeding advances.

Length of the Fattening Period. The length of the fattening period depends upon the age, size, and condition of the sheep at the beginning and also, to a certain extent, upon the type of the feed available. Lambs should gain about one third of a pound daily while on full feed and should be marketed at a 90 to 92-pound weight. A 60-pound lamb at the beginning will thus require about 100 days of feeding.

Yearlings and older sheep should be finished in 30 to 80 days, depending upon the condition of the animals at the beginning of the feeding period. The reason that less time is required for the older animals is that growth is slow or has ceased entirely and all the feed goes for the fattening process, while, for the lambs, a considerable portion of the feed intake goes for growth processes.

FACTORS AFFECTING MUTTON AND WOOL PRODUCTION

There are many factors, besides those related to feeding, that affect the economic production of mutton and wool. The inherited type and the condition the sheep are in at the beginning of the feeding period are very important factors affecting the outcome of the feeding operations. The age and sex of the fattening sheep are still other factors. Additional factors are: the effect of shearing, exercise, crossbreeding, and others.

Type of Sheep and Mutton Production. For market purposes, sheep are divided into four classes as follows: lambs, ewes, wethers, and rams. Each class is divided into subclasses which may again be qualified by age. For each subclass there is a number of grades. This classification, together with weight ranges for each class, are set forth in Table LIII, taken from U. S. Department of Agriculture Bul. 1360. With the exception of the lamb class, the classification of sheep is based upon sex. A brief description of each of these classes follows:

Lambs. Lambs include all sheep under 14 months of age, except those that are more developed than the age would indicate. On the market the classification is based upon the absence of permanent teeth. Sheep that have some permanent teeth, regardless of age, are not classified as lambs. There are two classes of lambs—spring lambs which are marketed under 5 months of age, and the older lambs. More than 90 per cent of the sheep marketed for slaughter are lambs.

Ewes. Ewes are all females that are too old or too far developed to be classified as lambs.

Wethers. All castrated males that are too well developed or too old to be classified as lambs are known as wethers. The preferable age of this group is the yearling. At this age it has two

TABLE LIII—MARKET CLASSES OF SHEEP

Class	*Sub-Class*	*Sub-Division*	*Weights*			*Grades*
			Handy	*Medium*	*Heavy*	
			Lbs.	*Lbs.*	*Lbs.*	
Lambs	Slaughter	Spring lambs Lambs	70-80	80-90	90-up	Prime Choice Good Medium Common Cull
	Feeder			60-70	70-up	Fancy Choice Good Medium Common Inferior
	Shearer			70-80	80-up	Choice Good Medium
Ewes	Slaughter	Yearlings		90-100	100-up	Same Grades as Slaughter Lambs
		2 years or over		120-140	140-up	
	eeder	All ages		All weights		Choice Good Medium Common Inferior
		Yearling		90-100	100-up	Fancy Choice Good Medium Common
		2 and 3 years		100-125	125-up	
		4 years and over		100-125	125-up	
Wethers	Slaughter	Yearling	90-100	100-110	110-up	Same as for Slaughter Lambs
		2 years or over	100-115	115-130	130-up	
	Feeder	Yearling		All weights		Same as for Feeder Lambs
		2 years and over		All weights		
		Yearling		All weights		Good Medium Common
		2 years or over		All weights		

broad teeth on the front of the lower jar, and they still possess the "break joint," that is, the cartilage in the joint below the pastern joint of the front leg has not yet disappeared. This cartilage may be felt by rubbing the foreleg at this point between the thumb and the forefinger, when a characteristic prominence may be detected.

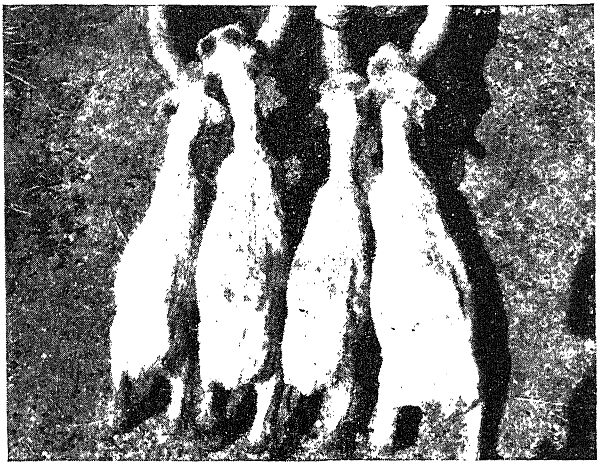


Figure 113. A group of poorly-finished lambs.

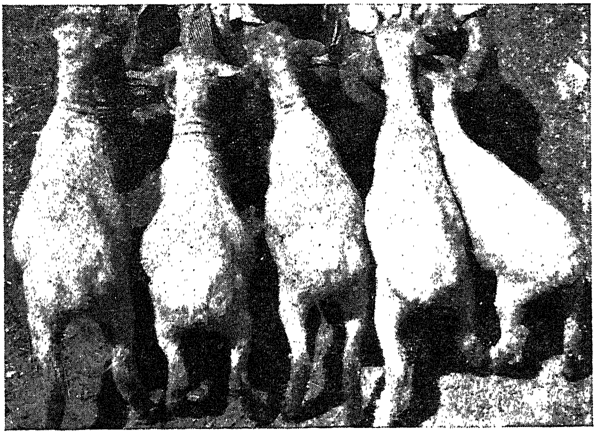


Figure 114. A group of thrifty lambs on feed.

Rams. Rams are all males too old or too mature to classify as lambs.

Grades of Sheep. Grades are important in both the purchase of the feeder sheep and when they are marketed. It will be noted from Table LIII that both slaughter and feeder lambs are divided into six grades. In general, the classification of the feeder lambs determines the limits to which such lambs will finish. In other words, inferior feeder lambs do not offer much hope of finishing into anything but common or perhaps medium slaughter lambs.

The form of the slaughter sheep as well as the finish is important in fixing its value. The prime carcass is one that not only is well finished but that has a well-developed leg, loin, and back from which the high-priced cuts are taken. In order to grade prime or choice, the whole carcass must present a full and even appearance and must be free from any roughness. Feeder lambs that come from the lower grades are not able to finish so as to meet these requirements.

Age and Mutton Production. It has previously been shown that lambs are in the greatest demand and command the highest market prices. The reasons for the commanding position of lambs are twofold. The retail cuts from lambs are smaller and meet more nearly the popular demand for size, and the quality of the flesh from lambs is more tender and less strongly flavored.

In the feed lot the lambs also have an advantage, as the gains per unit of feed are greater for lambs than for older sheep. The older sheep may gain as much per day, but a larger proportion of the total feed intake goes for maintaining the larger body and, therefore, more feed must be fed per pound of gain. This disadvantage for yearling wethers is somewhat offset by the fact that this class requires a shorter feeding period.

Sex and Mutton Production. In the lamb class there are no particular advantages for either sex. The wethers gain a little more rapidly than the females, but the ewes have a little more quality than the wethers, so that the two finish out in the same time, with the ewes weighing slightly less than the wethers. The feed requirements per pound of gain are the same for both.

Among older sheep, the wethers are superior to the ewes. The carcasses of wethers are thicker and smoother and dress out better. Older ewes are frequently pregnant which condition lowers the dressing percentage and the quality of the carcass.

Shearing and Mutton Production. There are two phases of the problem of shearing feeder sheep. One is the purchasing of shearer lambs and the other is to make the feeding sheep more comfortable by shearing. Shearer lambs are thin lambs that carry a heavy coat of fleece. The feeder buys these lambs both for the fleece which he will clip and the gains that can be put on them in the feed lot. Shearer lambs are usually shorn before the fattening process begins.

It is often advisable to shear sheep that are in the feed lot in order to make them more comfortable. Sheep should never be shorn during cold weather unless housed in a warm place. When the feeding period extends into the warm weather in the spring, it often becomes necessary to shear them, else they will suffer from the heat. Experiments have shown that, unless the weather is warm, there is no advantage in shearing fattening sheep. As a rule, the market value of shorn sheep is decreased proportionately to the value of the removed wool, so that there is no financial advantage in shearing.

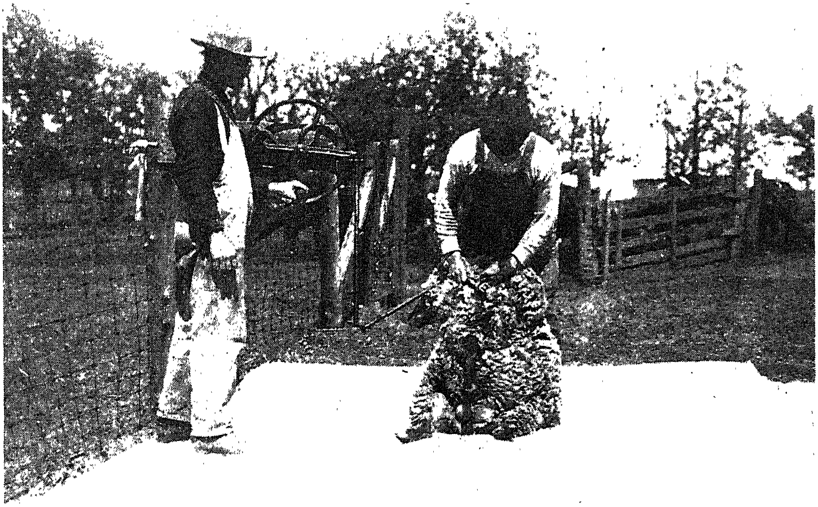


Figure 115. The proper posture for shearing sheep.

Problems in Shearing Sheep. The common practice is to shear sheep once during the year, although, in warm climates, twice-yearly shearing is often advocated. In the greater part of the country, sheep are sheared from the middle of April to the middle of May. This period is after the cold and before the warm weather. If sheared too early, severe damage may be done in exposure to the cold, and, if not shorn early enough, the sheep may suffer from the heat.

It was emphasized in *Agriculture II* that the price of wool is markedly influenced by the cleanness of the wool and the relative freedom from wool fat and suint. Dirt in the wool is to be avoided by proper handling of the sheep, such as preventing feed from falling upon the sheep and having the pastures and yards free from weeds or other material that will stick to the wool. The suint may be washed out of the wool before shearing, but such a practice is questionable. The weight of the wool is reduced proportionately to the amount of the suint that is removed; so, while the price per pound of the wool is increased, the number of pounds is reduced. Most people, however, shear the sheep without washing them and take the dockage for the suint and the wool fat.

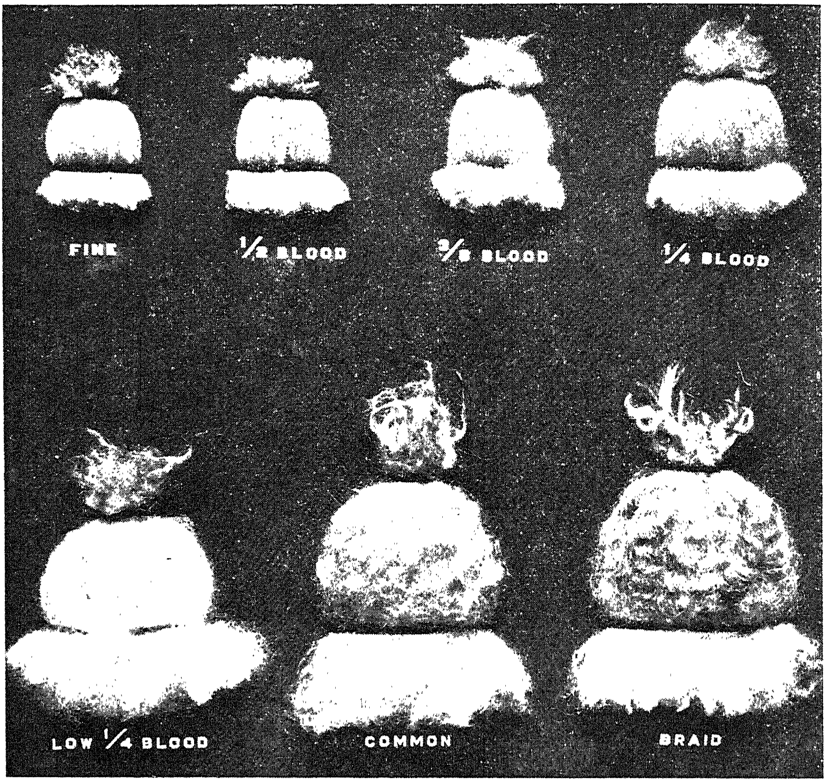


Figure 116. Grades of wool.

Good Shearing. Good shearing requires that the wool be clipped closely and smoothly without injury to the skin of the sheep. It is also important that the fleece be clipped without being broken. To prevent the sheep from struggling while being shorn, it is set on its rump with the back of its body tilted against the knees of the operator. In this position the hind legs can not gain contact with the floor. Whether hand or power shearers are used, the principle is the same. The clipping is started from the head and worked downwards in such a manner that the fleece is maintained in one piece.

After the fleece is removed, it should be rolled up with the flesh side out and all edges tucked in and then tied. In tying a fleece either paper or wool twine should be used. Any other kind of twine will contaminate the fleece with fibers that will lower the value of the wool.

To facilitate grading in marketing, the like fleeces should be packed together. The fleeces of similar color, yolk, suint, and length should be packed in the same bag.

Exercise. For the breeding flock exercise is essential and ample room for daily exercise should be provided in outside yards. For fattening sheep, experiments have shown that exercise reduces the rate of gain. Small yards are, therefore, preferable to large yards for fattening sheep.

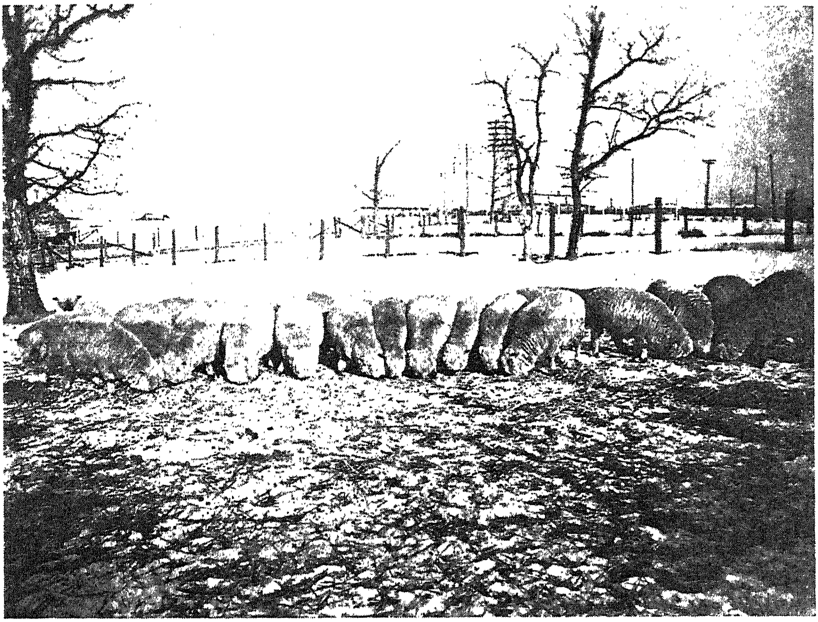


Figure 117. Pregnant ewes should be forced to exercise by furnishing the feed in the open away from the sheds.

Crossbreeding. Crossbreeding has been practiced on the range where mutton types have been used upon the Merino types to produce better mutton lambs. For range conditions it is important that a certain amount of Merino blood be retained to maintain the hardiness and the herding instincts that are so essential for the range. In England crossbreeding of strictly mutton breeds to produce mutton lambs is practiced extensively. The same claims are made in Great Britian for the crossbred sheep that are made for crossbred swine. These are: a higher per cent of lamb crop, more vigorous lambs, greater gains on the same quantity of feed, and higher quality of the carcasses.

DISEASES ENCOUNTERED IN THE FEED LOT

The more common diseases affecting the breeding flock have been discussed in *Agriculture II*. The more common ailments affecting sheep in the feed lot will be briefly considered. On account of the previous history of sheep shipped in to be fattened and the intensive feeding that follows, sheep in the feed lot are frequently subject to certain ailments that must be carefully watched, else heavy losses may be entailed. Among these ailments are hemorrhagic septicemia, digestive disturbances, urinary calculi, and pneumonia.

Hemorrhagic Septicemia, or shipping fever, as it is sometimes called, is an infectious disease identical with that of cattle. The symptoms are the same as in cattle. The animal becomes listless, losses its appetite, develops difficulty in breathing, often followed by pneumonia. After death, small hemorrhagic spots are found on the internal organs. Affected animals should be separated from the rest of the flock and placed in a warm dry place. The healthy animals should be vaccinated to prevent further spread of the disease.

Digestive Disturbances. The most frequent ailment of sheep in the feed lot is some digestive disturbance. Some of the disturbances may be infectious; but, in the majority of cases, the ailment is due to improper feeding. The ailment is usually first indicated by a decline in appetite, followed by diarrhea. As with any other ailment, the affected sheep should be removed from the healthy ones. If the disturbance is due to an infection, a veterinarian should be called. If the trouble is due to improper feeding, the animals should be given some laxative, such as a teaspoonful of castor oil. They should then be put on a bulky diet, preferably oats and bran, until complete recovery is made. They may then be returned to the feed lot.

Urinary Calculi. Stonelike formations may develop in the bladders and kidneys of rams and wethers and cause a retention of the urine. The affected animal usually strains, quits eating, and the abdomen becomes distended. There is no effective treatment for the ailment. Claims that the stones are caused by roots are not supported by facts, as animals not on root diets may also be affected.

Pneumonia. Heavily-fed sheep are subject to pneumonia. The disease may be kept to a low level by preventing crowding, furnishing dry quarters free from drafts, and maintaining a general healthy condition of the flock.

MANAGEMENT OF THE FLOCK DURING THE BREEDING SEASON

As with any other class of livestock, a high reproductive efficiency is essential for economical production. The principle of flushing the ewes before the breeding season in order to increase the lamb crop has been treated in *Agriculture II*, but there remains the consideration of the ram and the techniques used during the breeding season.

Care of the Ram. It is best, for two reasons, that the ram should not be permitted to run with the flock before the breeding season. First, a nervous ram is not likely to eat sufficiently and may be in a weakened condition for the breeding season. The breeding efficiency is thus reduced. The second reason is that ewes that come in heat early will be bred and lamb too early.

For the best breeding efficiency, rams should be in moderate flesh. Fat rams, like thin ones, are usually slow breeders. The ram should have plenty of exercise prior to the breeding season. It can best be provided by keeping him on pasture. During this time good pasture is usually all the feed that is needed. During the breeding season, however, he should be fed some grain. For a moderate-sized ram a fair ration is one pound of a mixture of equal parts of oats and bran.

If the ram can be kept in the desired condition during the breeding season, it is well to let him run with the ewes at all times. If, however, the ram is of such a temperament that he will not eat under such conditions, he should be permitted with the ewes for but two hours daily.

Marking the Ewes. It is desirable to know when the ewes are bred, so that a record may be kept from which the lambing date may be calculated. As an aid for fixing the date the brisket of the ram is smeared with a colored paint that will be transferred to the ewe during the breeding. The ewe may have her number stenciled upon her side, so that she may be easily identified. The paint for the ram and the stencil is made by mixing ochre in mineral oil to form a thick paste. It will not injure the wool. As the oestrus cycle of the sheep is 16 days, it is a good practice to change the color of the paint each 16 days in order to catch the ewes that are rebred.

Number of Ewes per Ram. The number of ewes that may be bred by a ram varies with the vigor of the ram. A moderately vigorous ram will serve 35 ewes in a season and a very vigorous one from 50 to 75. By the use of artificial insemination several hundred ewes may be bred from one ram.

Suggestive Questions

1. Describe the housing needs and satisfactory equipment for fattening sheep.
2. How does the feeding of fattening sheep differ from the feeding of the breeding flock?
3. Under what conditions is it necessary to furnish protein supplements to fattening sheep?
4. Compare legume hay, silage, and nonlegume hay as roughage for fattening sheep.
5. Name the conditions under which the grains should be ground for sheep?
6. Compare the relative merits of hand feeding and self-feeding.
7. How is the length of the fattening period determined?
8. What is the relation between the age of the sheep and the efficiency of gains?
9. To what extent does sex of the sheep influence mutton production?
10. Under what conditions may fattening sheep be sheared?
11. Describe the proper way to shear sheep and care for the wool.
12. What are the positive effects of crossbreeding upon economy of mutton production?
13. Describe the more common ailments of sheep in the feeding lot and how each should be handled.
14. Give the important points in the proper care of the ram during the breeding season.
15. What principles govern the number of ewes a ram may serve during a season?

Suggestive Activities

1. Prepare plans for a suitable building, pens, and equipment for feeding a carload of lambs. (There are 300 lambs in a double-deck carload.)
2. Prepare a feeding schedule for feeding a carload of lambs for a period of 100 days.
3. Assuming a gain of 0.33 pound per head per day, calculate the cost of gain for a 100-day feeding period, starting with lambs weighing 60 pounds.
4. Examine a lot of lambs that are being fattened. Determine their condition and in what different market grades they may be classed.
5. Ascertain the cost of feed, the cost of feeder lambs, and the price of the finished lambs, and calculate the margin of profit above feed cost.
6. Shear some sheep and tie and sort the wool.
7. Make a marking paint for the ram.

CHAPTER XXIV

MANAGEMENT OF POULTRY

Although poultry production has been treated more completely in the previous volumes of *Agriculture* than any of the other farm animal enterprises, there still remain important problems for consideration. We must yet consider some additional factors that affect economical production, the production of quality eggs, factors involved in the deterioration of eggs, the preservation of eggs in the home, the production of meat, caponization, and the breeding of poultry.

FACTORS AFFECTING ECONOMICAL EGG PRODUCTION

In previous volumes it was shown that high egg production per bird is essential to economic production. There, too, it was shown that, in order to have a high-producing flock, birds with poor inheritance for production must be culled, disease must be eliminated, comfortable housing must be provided, and the laying birds must be properly fed. One of the first problems in the economical production is to make an economical ration, as the cost of feed is the largest item in the cost of producing eggs.

Suitable rations have been presented, but there are many other combinations that will produce satisfactory results. A discussion of the values of the individual feeds that may be used for poultry feeding will enable one to prepare suitable rations from a wide variety of feedstuffs when the requirements for the birds are known. The essentials of a good ration are given on page 422, *Agriculture II.*

The different feeds used in the feeding of poultry may be divided into the cereal grains and their by-products, and the protein, mineral, and vitamin supplements.

Cereal Grains and By-products. The cereal grains form the greater part of the poultry ration. The cereal grains fed poultry include wheat, corn, barley, grain sorghums, rye, oats, and, sometimes, buckwheat.

Wheat. Wheat is usually regarded as the best grain for poultry feed, although it is not necessarily so, when other cereal grains are properly supplemented. From the standpoint of palatability, wheat ranks at the top and produces excellent results, but is usually high-priced. Frosted wheat that can not be used for milling purposes has about the same value for poultry feeding as the normal wheat.

Of the by-products of wheat, middlings, red-dog flour, and shorts are the only ones that are adapted to poultry feeding. These by-products are a little higher in their protein contents than the wheat but also higher in fiber content. Wheat bran, because of its high-fiber content and low digestibility, is not suited for poultry feeding, except in very limited quantities.

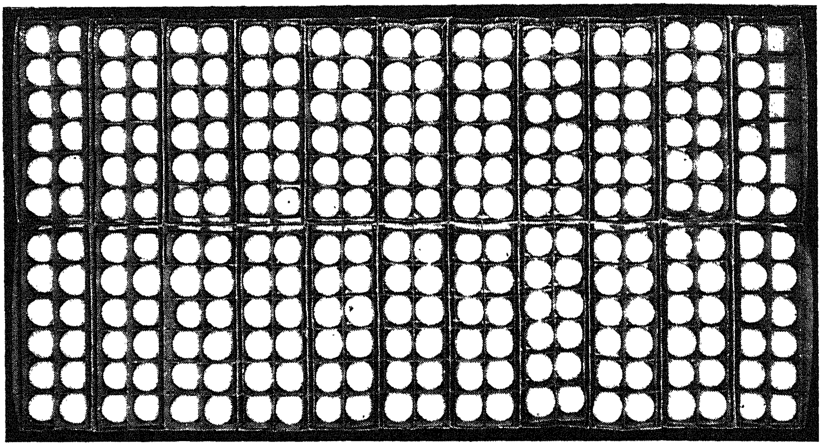


Figure 118. Clean uniform-sized eggs are attractive when properly packaged.

Corn. From a large number of experiments corn has been proven one of the most valuable of feeds for poultry, provided it is properly supplemented. It is one of the most palatable of feeds for poultry and is the lowest of all natural grains in fiber content. It yields more digestible nutrients than any other grain. Yellow corn also furnishes some of the Vitamin A precursor. Yellow corn on account of the pigment xanthophyll, will also impart a deeper color to the egg yolk and the body fat.

Corn may be fed whole or cracked, but should not be ground. There is no particular advantage in feeding anything but whole corn, except in fattening poultry, when ground corn may be fed.

There are three by-products of corn that may be used as poultry feeds. These are: hominy feed, corn gluten, and corn-germ-oil meal. Hominy feed has the same composition as the corn and can be used in place of it. The other two are high in protein and will be considered under protein supplements.

Barley. Barley ranks below both corn and wheat both from the standpoint of palatability and digestible nutrients. Barley contains about 6 per cent fiber and corn contains about 2.3 per cent. Although barley is not as palatable as corn or wheat, chickens will learn to like it sufficiently well to make this grain a valuable part of the ration when the price is low. Low-grade barleys may have as much as 14 per cent fiber and are not adapted to poultry feeding.

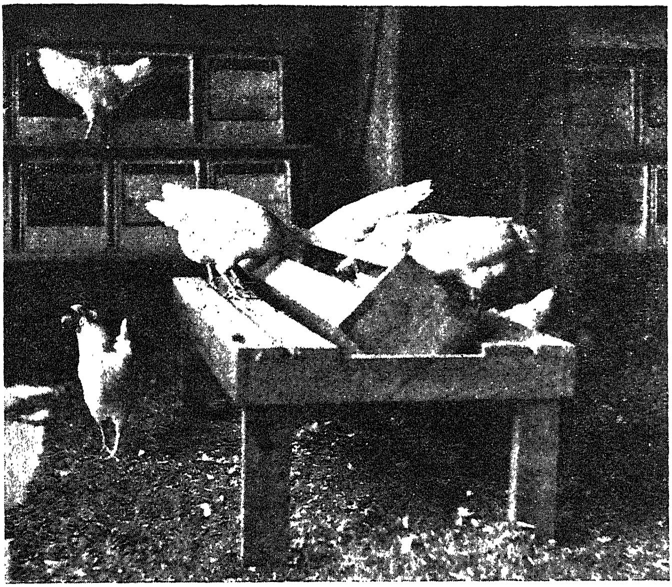


Figure 119. A type of feeder that conserves feed and floor space.

The Grain Sorghums. Milo, kafir, and feterita are the more common of the grain sorghums. In composition they are very similar to corn and in nearly all cases they have approximately the same feeding value. While the palatability is not quite as high as that of corn, these three grains are sufficiently palatable and can be substituted quantitatively for corn in any ration.

Oats. Although used to a considerable extent in poultry feeding, oats rank rather low as a poultry feed. They contain about 10 to 12 per cent fiber, and, as a result, have a rather low feed value for poultry. Poultry can not digest the crude fiber as horses and cattle can, and, therefore, feeds with high-fiber contents have rather lower feeding value for birds than for horses and ruminants.

Hulled oats are an excellent feed for poultry and have a value equal to that of wheat or corn.

While oats have a relatively low feed value for poultry, they are quite palatable and chickens will eat a large quantity. Mixed in with other feed, oats may be used in the ration to a limited extent. Only heavy-weight grain should be used, as lightweight oats may contain up to 15 or more per cent fiber.

Rye. Rye is not suited for poultry. While rye has the same composition as wheat, this grain is unpalatable and affects the birds adversely. Rye-fed birds grow much more slowly than those fed upon wheat. They also appear listless. The digestive tract is upset and the droppings become sticky and pasty.

Protein Supplements. As none of the cereal grains discussed contains an adequate amount of protein, it becomes obvious that, for successful poultry feeding, some high-protein supplement must be furnished. Protein supplements for poultry may come from two sources—animals and plants.

Animal Protein Supplements. The animal proteins used in poultry feeding include milk and milk products, tankage, meat scraps, and fish meal as the more common ones. That at least one fourth of the total protein supplement should be of animal origin has been generally shown by experiments. If the price is not prohibitive, it is preferable that all the protein supplement be of animal origin. This preference is due to the superior supplemental value of animal proteins to those of the cereal grains.

Skimmilk and Buttermilk. Skimmilk and buttermilk may be fed either in the liquid or the dried form. Extensive experiments place these products at the top of the list of protein supplements. Skimmilk is also a very good source of Vitamin G or riboflavin. As it takes 10 pounds of liquid milk to equal one pound of dried buttermilk or skimmilk, when the milk is furnished in the fluid form, care should be taken that such a ratio be maintained.

When the milk is fed in the fluid form, there is no evidence that there is any difference in values between sweet and sour milks. Whey, the by-product from cheese production, is low in its protein content and, therefore, not suited for poultry feeding.

Meat Scraps. Meat scraps or dry rendered tankage contain about 55 per cent protein, which supplements the cereal grain proteins very well. Meat scraps are used more than any other protein supplement. The ordinary meat scraps contain about 4.3 per cent of phosphorus and 8.7 per cent of calcium. Meat scraps with higher content of phosphorus and calcium must be labeled as meat scraps or dry rendered tankage with bone meal. The latter product usually contains not more than 50 per cent protein.

Tankage. Tankage resembles meat scrap in composition and differs from it mostly in the process with which it is made. Tankage comes in different grades, depending mainly upon the quantity of protein it contains. The highest grades of tankage contain 60 or more per cent of protein. Some grades are as low as 40 per cent in their protein content. The higher grades are to be preferred for poultry feeding.

Fish Meal. Fish meal is used extensively as a protein supplement, particularly in the coastal regions. Fish meal comes in a number of different grades based upon the protein content. The highest grades contain more than 60 per cent. Although a good source of both calcium and phosphorus, the fish meals are somewhat lower in these two constituents than the meat scraps and tankages. As a protein supplement, fish meal is equal to a comparable grade of meat scraps.

The Vegetable Protein Supplements. The vegetable protein supplements are not as efficient as the animal protein supplements. The vegetable proteins are generally lower-priced than those of animal origin, and, for this reason, it is often desirable to include them in the poultry ration. When the vegetable proteins are sufficiently lower in price than the animal proteins, they may be used up to three quarters of the total protein supplement, but, preferably, not more than one half. While any one of the protein feeds used for other classes of livestock may be used for poultry, linseed meal, cottonseed meal, soybean meal, corn-gluten meal, and peanut meal are the more commonly used ones.

Linseed-Oil Meal. The new process linseed-oil meal contains up to 37 per cent protein, which is fair in its supplemental value to the cereal grains. Linseed-oil meal usually has a laxative effect upon the digestive system, which, under some conditions, is desirable. Because of this effect of this feed, it is best never to use more linseed-oil meal than 5 per cent of the total ration.

Cottonseed Meal. For a large section of the country cottonseed meal is the lowest priced of all sources of protein, and, for this reason, its use is very desirable. Some experiments have shown cottonseed meal to be more effective in supplementing the cereals than linseed meal. Cottonseed meal is not as palatable for young chicks as meat scraps are. For laying hens there are objections to the use of more than 5 per cent of the total ration, as, above that figure, cottonseed meal has a deleterious effect upon the egg. The yolk becomes discolored and the hatchability is reduced.

Claims that cottonseed meal is toxic for poultry are not substantiated by recent experimental work, at least when it is fed in moderate quantities.

Soybean Meal. Soybean meal seems to be one of the best of the vegetable protein supplements for chickens, as it has a higher supplemental value to the cereal grains than any of the other plant products. At that, it should never be fed in quantities greater than 75 per cent of the protein supplement, and the other proteins should be of animal origin.

Ground soybeans are not as satisfactory a source of protein as the meal. They are fairly satisfactory when they make up not more than one third of the protein supplement.

Corn Gluten Meal. Corn-gluten meal is a by-product of the corn grain, and, as would be expected, does not supplement the ration efficiently when corn constitutes a large part of the ration. For other grains it is better but does not equal soybean meal under any condition. When corn-gluten meal is used, it is best to limit the quantities to not over one half of the protein supplement.

Corn-gluten feed, in addition to having the faults of corn-gluten meal, is much lower in protein content and somewhat higher in its fiber content. For these reasons, this product is not advised as a protein supplement.

Vitamin Supplements. As previously stated, poultry have rather high-vitamin requirements, and the two most important Vitamins A and D are either entirely lacking or very deficient in all the plant seeds which constitute the bulk of the ration. It is, therefore, essential that vitamin supplements be furnished in some form. During the summer, when the birds are on the range, the vitamin requirements are generally met in the green forage and the exposure of the birds to the direct rays of the sun. When the flock is confined indoors, the vitamins may be supplied in several different ways. Greens, leaf meals, fish-liver oils, and fresh liver are the more common methods of furnishing these requirements.

Greens. All growing green plants are relatively rich in their carotene (precursor of Vitamin A) content. During the growing season such substances as green legumes, green grass, rape, and kale are excellent feeds for poultry. As none of the green plants contains any Vitamin D, this substance must be furnished in some other form. In addition to furnishing Vitamin A, the green plants, being succulent, are believed to have further beneficial effects.

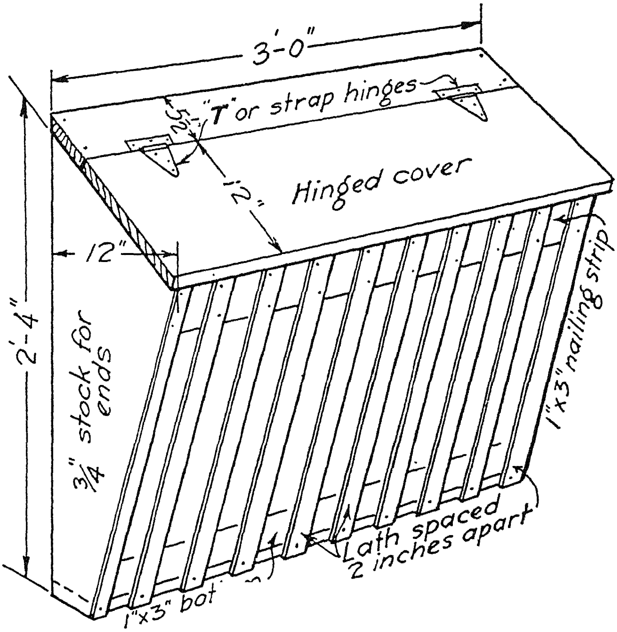


Figure 120. A suitable rack for feeding alfalfa.

Leaf Meals. The most popular and one of the cheapest sources of Vitamins A, G, and D is well-cured alfalfa-leaf meal. This product is readily procurable and is also quite palatable to poultry. One of the easiest ways of handling alfalfa-leaf meal and insuring that sufficient quantities shall be consumed is to mix it in the mash to the extent of 5 per cent. Red clover leaves, cured in a similar manner, rank next to alfalfa-leaf meal.

Fish-Liver Oils. The most potent source of Vitamin A and D is the fish-liver oils. Of these cod-liver oil is the most commonly used, although sardine oil and puffer oils are equally good sources of the vitamin. Many of the oils upon the market are reinforced with either Vitamin A or D, and, therefore, in purchasing any of these supplements, one should buy them on the basis of the guaranteed potency of each of the vitamins. As a rule, during the winter from one fourth to one half pint of ordinary cod-liver oil should be mixed in the mash daily for each 100 birds. As the Vitamin A is destroyed by long exposure to the air, it is best not to mix large quantities of feed containing these oils.

Liver. Fresh liver of any of the species is an excellent source of both Vitamins A and D, as well as of several other vitamins for which the liver is the storehouse. Liver is usually too expensive to be included in the ration of the entire flock, but is often to be considered for the ration of the breeding hens just before and during the time eggs are collected for hatching.

Mineral Supplements. For no other class of farm animals are mineral supplements so important as for the laying poultry. In addition to the requirements for the body, there are those for the production of the egg. The contents of the egg need relatively large quantities of calcium and phosphorus, but the chief mineral requirement is for the production of the eggshell which is mainly calcium. The cereals, which are the natural feeds for poultry, are fairly rich in phosphorus, but are very low in calcium content. The cereals, too, are deficient in common salt, and in some communities there may be a deficiency of iodine. The salt requirements are met by mixing from ½ to 1 per cent of common salt with the mash. Calcium may come from a number of sources of which bone meal, ground limestone, and marine shells are the most common. Iodine, when deficient, may be supplied in adequate quantity by iodized salt.

Bone Meal. Bone meal contains, on the average, 32.5 per cent of calcium and 15 per cent of phosphorus and is an excellent source of these two constituents. To insure adequate phosphorus and at the same time supply some additional calcium, bone meal may be added to the mash to the extent of 4 per cent.

Ground Limestone. As most of the limestone contains impurities of which magnesium salts are the chief ones, this mineral has been found to be a poor source of calcium. When ordinary limestone has been compared with oyster shells, the latter have given better results. High-grade limestone containing 85 per cent or more of calcium carbonate is a very satisfactory source of calcium. Marl, which is of similar composition, is also satisfactory.

Marine Shells. There are two general sources of marine shells. One is oyster shells and the other is clam shells. In composition there is no appreciable difference between the two, but oyster shells are generally preferred to clam shells. One reason given for this preference is that the oyster shells contain more iodine, which would produce better results in iodine-deficient areas.

Miscellaneous Feeds. There are numerous miscellaneous feeds that can not be classified under the previous heads and that are fed to poultry. Among these are grit, roots, and succulent feeds, charcoal, and molasses.

Roots and Succulent Feeds. Roots and some vegetables are supplied primarily as a source of succulence and as a means of forcing the birds to take exercise. Roots and vegetables may be suspended, so that the birds must jump in order to feed on them. Beets, mangels, carrots, cabbage, potatoes, and other forms are used for poultry feeding. In addition to furnishing succulence, all these supply some nutrients; but, with the exception of potatoes, they are relatively unimportant as sources of nutrients. Most of the roots contain over 90 per cent of water, while potatoes average about 79 per cent of water.

Carrots, because of their high carotene content, also serve as a source of Vitamin A, while other roots are practically devoid of this vitamin.

Potatoes may be used to advantage in feeding either laying or fattening poultry. When used, they may be fed either raw or cooked. The approximately 21 per cent of dry matter in potatoes is mostly starch and highly digestible.

Grit. The need for grit and the method of feeding it have been discussed previously. There are several different substances that will serve as grit and some of those used are not satisfactory. In order to be satisfactory, grit must be hard and resistant to the digestive action of the bird. Oyster shells and limestone are not good substances for grit because they are dissolved by the acid of the digestive tract. Among the satisfactory substances for grit are crushed granite, rock phosphate, feldspar, and quartz.

Charcoal. Charcoal is relished by chickens, although its real value is unknown. It has a great capacity for absorbing gases and it may be that, in some diets, there is need for such a compound. There is no evidence that charcoal does any harm, and, when available at no great cost, it may be to poultry ad libitum.

Molasses and Sugar. Molasses has been tried experimentally both as a source of nutrients and as a means of increasing the palatability of the ration. In neither case has it been found to have any particular advantage, although it may be included in the ration up to 10 per cent. Likewise, there is no evidence that sugar has any beneficial effect when included in the ration.

ADDITIONAL MANAGEMENT FACTORS

While the general management problems have been considered in *Agriculture II*, a few of the major problems should be reemphasized and several others will be considered. The importance of proper feeding, housing, and regularity in the care of the flock will be restated. The sexing of chicks, crossbreeding, production of broilers, and capons and caponizing will be treated at some length.

Feeding and Housing. While the principles of feeding and housing have been discussed in *Agriculture II,* these features are of such importance in profitable poultry production that further mention must be made. To understand the problem thoroughly, let it be emphasized that, in nature, the chicken produced eggs only in the spring. It is reasonable to state that the laying of eggs under natural conditions was conditioned to a large extent by the favorable climatic and food conditions of the spring. Under domestic conditions, it is desirable that egg production be at its height at the time that the wild hen was dormant in this respect.

In order to effect egg laying during the fall and winter months, it is essential that the feed and environment be such that this production will be stimulated during a time when normally there is no natural stimulus. The housing should, therefore, be such that the birds are kept comfortable, and the feed should be abundant and contain all the needed nutritive elements. These requirements have been discussed in *Agriculture II* and need no further treatment at this time.

Trapnesting. Whenever it is desirable to keep a record of the number of eggs laid by a hen it is necessary to use a trap nest. The principle of the trap nest is that the hen, upon entering the nest, springs a trap and shuts herself in the nest until released.

There are some inherent errors in trapnesting, one of the greatest of which is that a hen will occasionally lay an egg upon the floor.

Sexing Chicks. It is very desirable that the males be separated from the females early. There are two methods by which this separation may be accomplished. One is by examination of the chicks and the other is by a system of crossbreeding which will be discussed later.

Chicks that are to be sexed should be preferably not more than one half day old, because the job becomes increasingly difficult as the chick grows older. To determine the sex of the chick, the anus is everted, so that the sex organ may be observed. Eversion is effected by putting pressure upon the ventral (lower) side of the anus by the thumb of the hand in which the bird is held and at the same time the lateral sides are pressed between the thumb and the forefinger of the other hand. The bird is held on its back in the left hand with the posterior end in such a position that the thumb of the left hand can be brought down upon the ventral side of the anus. The thumb and the forefinger of the right hand can then squeeze the lateral sides until eversion is accomplished.

The genital organ is located in a fold on the rim of the lower side of the anus and may be seen as a small elevation resembling a tiny pimple. It will require some practice before the organ can be seen and classified as to whether it is a male or a female organ. In the majority of females the organ is absent and in the majority of the males it is relatively prominent. In about 20 to 30 per cent of the chicks the development of the genital organ is such that it may be either female or male. It is, therefore, impossible to separate all the males from all the females; but, by selecting all those with fairly prominent organs, a group representing about 70 per cent of all males can be separated.

Crossbreeding as a Method of Sexing. Certain breeds or varieties may be crossed to produce differentiating characters between the sexes. This method is used by some commercial hatcherymen, so that they can fill orders of all pullets for those who want only egg production, and the males are furnished to those who produce only broilers.

The two most common crosses used are the barred-black cross and the gold-silver cross. For the barred-black cross Barred Plymouth Rock females are mated to either Black Leghorn, Black Minorca, or Australorp males. All the pullets from this cross are solid black at hatching, while the males have a white spot on top of the head.

For the gold-silver crosses, Rhode Island Red males are mated with either Light Sussex or Columbian Wyandotte females. The pullets from such a cross are all deep red, while the males are of a silvery yellow.

Feeding Broilers. The production of broilers has become a large and highly-specialized business. While any breed may be used for broiler production, the heavier breeds are preferred. Barred Plymouth Rocks and Rhode Island Reds are the preferred breeds. Barred Plymouth Rocks and Rhode Island crosses are also desirable. Because males make more rapid gains than females, they are preferred.

The object in feeding broilers is to bring them to the desired weights in as short a time as possible. It is not unusual to have broilers weighing 2 pounds at 8 weeks of age. Weights of 2½ to 3 pounds in 12 weeks are good.

As compared with the raising of breeding stock, it is necessary, in order to obtain the fast growth desired, to feed larger quantities, increase the protein in the ration, and restrict exercise. The regular mash used for the breeding stock may be used if the protein supplement is increased from 10 to 20 per cent.

If the broilers are to be sold on a local market, they should be milk-fed to be rated as finished. This feeding should be done as directed for fattening poultry, page 428, *Agriculture II.* If the broilers are to be shipped, it is inadvisable to milk-feed them before shipping, as such birds shrink unusually much in shipping. A better practice is to pen the birds two to three weeks before marketing and fatten them on corn. Birds fattened in this way are in good shape for milk fattening by the packer.

Capons. Capons, or unsexed males, are in demand for special trade. The advantage of the capon over the rooster is that its flesh retains the broiler texture and flavor until nearly mature size has been attained. It is, therefore, customary to grow the capons for nine to twelve months. The capons are more docile and quiet than the roosters and, therefore, make more economical gains. The question as to whether or not one should produce capons depends upon the market that is available. Unless a good market is available, it is better to market the males as broilers.

All breeds may be caponized, but the heavier breeds with yellow skin are more favored. Some have made a specialty of Leghorn capons, not that they are generally favored, but because their smaller size appeals to smaller families. The Jersey Giants, Brahmas, and Cochins rank first, because their weights are heavier when marketed. They are followed by Rocks, Wyandottes, and Rhode Island Reds.

Caponizing. Anyone can learn to caponize. After deciding that it is advisable to caponize, the following important considerations remain: when to caponize, the instruments necessary, the technique in the operation, the immediate care of the bird, and the feeding and care of capons.

Time to Caponize. There are two factors that determine when to caponize. These are the time that the capons are to be marketed and the size of the birds at the time of the operation. As the best time to market capons is from Christmas to March and birds should weigh about 1½ pounds when operated upon and should be 9 to 12 months old when marketed, the time for caponizing becomes limited to May, June, and July. Size is a fairly important factor in caponizing. If the birds are too small, the testes are small and difficult to locate. If the birds are too large, over 2 pounds, the testes are large and so close to the arteries that there is danger of puncturing them in the operation, in which case, of course, the bird will bleed to death.

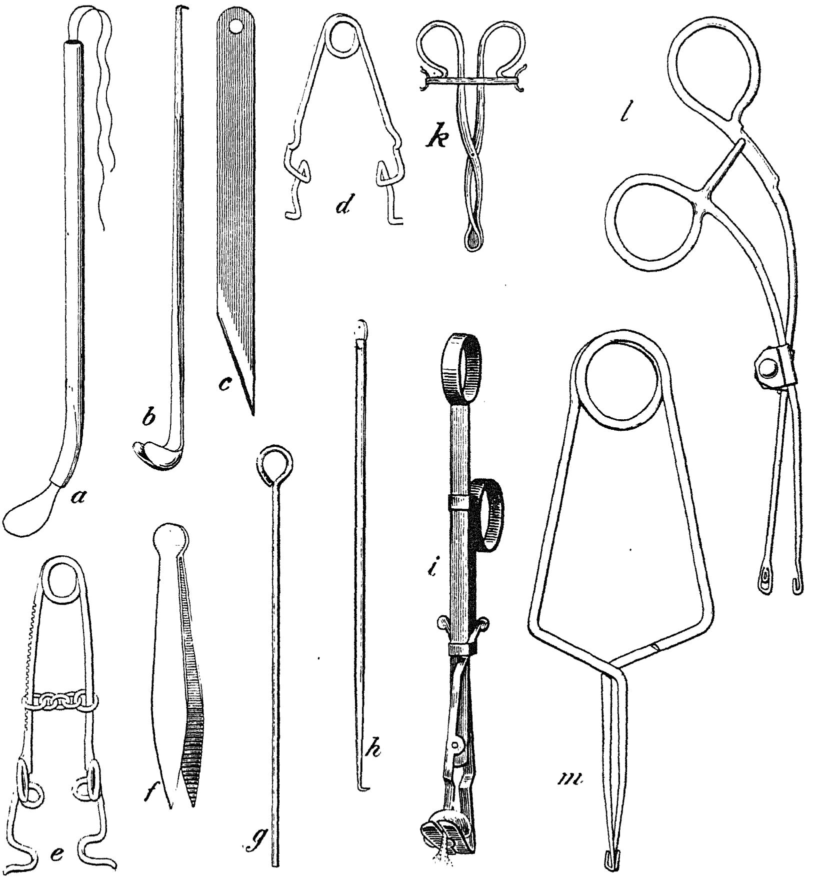


Figure 121. Instruments for caponizing. A, B, I, L, K, and M are different types of testicle removers. D and E are different types of spreaders to hold open the incision. C is the knife for making the incision. H is a hook for tearing the membrane and G is a probe for pushing the intestines aside. The tweezers, F, may also be used as a probe.

Instruments for Caponizing. Instruments for caponizing are procurable in sets from poultry-supply houses. Different sets differ somewhat in design and type of the various instruments;

but, in the main, the typical set consists of a scalpel, or sharp knife for making the incision, a sharp-pointed hook for opening the membrane lining the abdominal cavity, spreaders for keeping the incision open during the operation, a probe for use in locating the testes, and one of the different types of instruments for removing the testes.

In addition to the instruments, a table of some sort is needed upon which the bird can be placed during the operation and upon which a sponge and a pan of water may be kept at hand. There should also be room for a pan in which the instruments may be conveniently spread.

Performing the Operation. Before attempting to caponize live birds it is well to get some experience by performing the operation upon dead birds that are to be dressed. One may thus gain necessary experience and technique to insure success in the first operation upon living birds. Following the development of the necessary skill, living birds may be operated upon according to the following directions:

Before caponizing, the birds should have been kept from food and water for a period of 24 to 36 hours. Next, a well-lighted place, preferably the outdoors on a bright day, should be chosen for the operation.

In preparing the bird for the operation the first problem is that of securing it upon the table. Both the feet and the wings must be tied in such a manner as to prevent any movement of the bird during the operation and at the same time cause no obstruction to the worker. The legs should be drawn backwards and tied just above the feet with a cord to the free end of which is affixed a small weight. The weight is permitted to hang over the edge of the table. The wings are secured by tying a cord around the first joint and letting the weight affixed to the free end hang over the edge of the table opposite to that of the feet. The bird lies upon its side as shown in Figure 122. The feathers are then removed from the area where the incision is to be made.

To make the incision the operator stands directly back of the bird. With one hand the skin over the first and second ribs is drawn toward the thigh, while the cut is made with the scalpel held in the other hand. The incision should be made between the first and second ribs. It should be made commencing about an inch and a half from the backbone and cutting toward the back. An opening of not more than 1¼ inches should be made. In performing this part of the operation care must be taken to follow

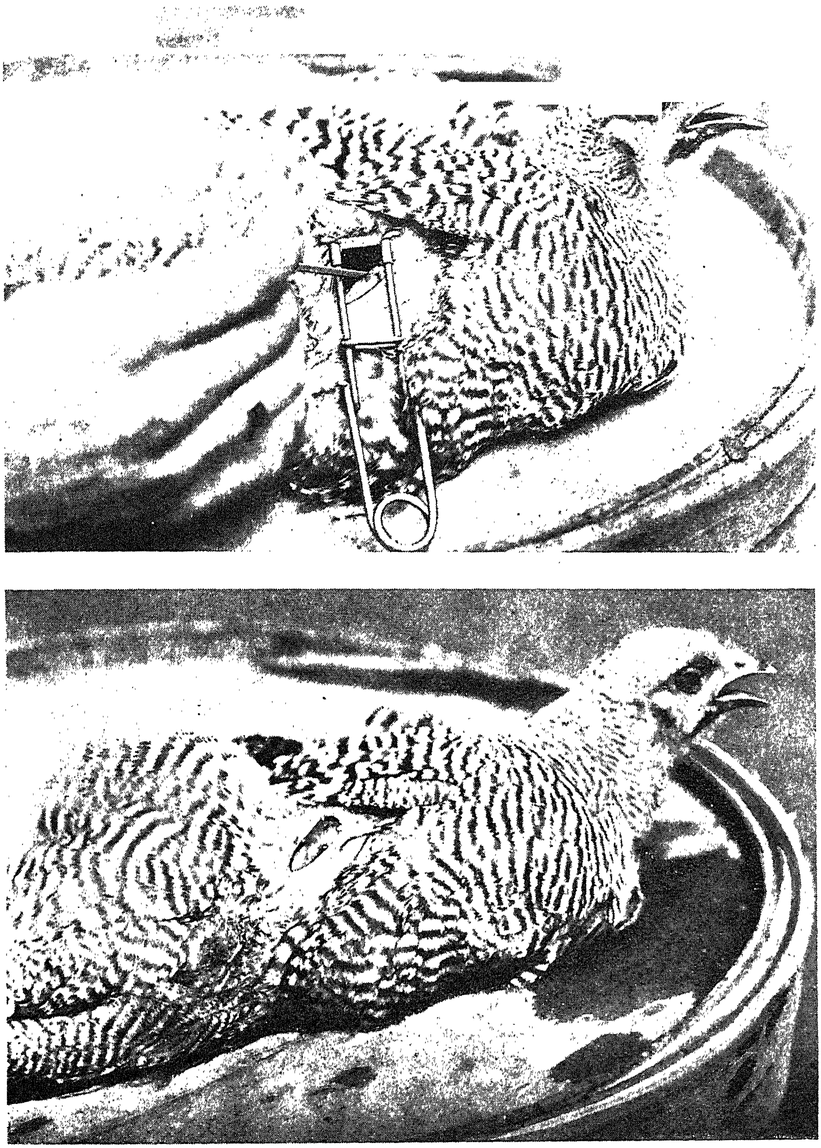


Figure 122. Above is the bird with the incision made and with spreaders in place. Note how the instrument for removing the testicles is handled. Below is the bird showing the incision immediately after the spreaders have been removed.

the curvature of the ribs and to avoid cutting too deep. When the cut is properly made, the covering over the intestines is not touched but exposed. The membrane covering the intestines must not be cut, but is torn apart with the tissue hook for the length of the incision. Care must be taken not to insert the tissue hook too deeply, else the intestines may be injured.

The spreaders are now inserted to hold the cut edges apart and facilitate the remainder of the operation. The near testicle may be observed just in front of the kidney and below the backbone. It is bean shaped and about the size of a kernel of wheat. It is removed with one of the several different types of testes removers, care being taken to get all the testicle and not to injure the blood vessel lying immediately below. Injury to this vessel is one of the greatest hazards in caponizing, as it will cause the death of the bird from bleeding. The second testicle may be removed from the same incision; but, for beginners, it is preferable to make an incision on the other side for this purpose.

When both testicles are removed from the same incision, the lower one should be taken out first. It is first made clearly visible by the aid of the probe and then the testicle remover is carefully affixed, so as to include the entire testicle, care being taken not to include the blood vessel, which, in this case, is to be found on the near side. After the testicles are removed, the spreaders are withdrawn and the bird freed.

If any part of the testicle remains intact, it will develop and the bird will have all the characteristics of a normal rooster. Such birds are usually known as "slips."

Care of the Birds after the Operation. As the birds are very hungry and thirsty immediately after the operation has been completed, they should be supplied with water and a light feed consisting, preferably, of a mash containing 2 parts of corn and 1 part of wheat. This mash is made up to a thick slop with milk.

For the first three or four days after the operation the birds should be confined in a room without roosts, as flying up to roosts or jumping down from them will open the healing wound. It is also well not to have any litter upon the floor, as the hungry birds may eat it.

For the first two or three days following the operation a swelling under the wing around the incision is to be expected. When the swelling becomes inflated, as often occurs, when it is called "wind puffs," it should be punctured to let the gas out.

Feeding Capons. During the growth of the capons their feed and care should be the same as for the breeding flock, except that a little more feed should be furnished. At the end of the growing season, when the birds are to be fattened, they should be allowed all the grain and mash they will eat.

FACTORS AFFECTING THE QUALITY OF EGGS

Good managers always want to produce high-quality products, no matter what the class of livestock may be. The production of high-quality eggs pays in two ways—first, increased value of the product, and, secondly, the greater satisfaction gained from producing a superior product. Every good manager wants to know what is meant by quality in eggs and what factors make for quality.

Quality and Grades of Eggs. High-quality eggs are large and clean, uniform in size and color, have a clean desirable flavor, have whites and yolks that stand up when the eggs are broken, have a strong shell, are free from defects, and have good keeping qualities.

Grades of Eggs. Different states have different standards for the grades of eggs and each person should familiarize himself with the laws regulating the grades of eggs in his state. The market quotations on eggs are based upon the standards of the U. S. Grades, of which there are five—U. S. Special, U. S. Extra, U. S. Standard, U. S. Trade, and U. S. Checks.

U. S. Special. This grade is of the highest quality. The shell must be clean and sound. The air sac must be not more than one eighth of an inch deep, localized and regular. The yolk may be dimly visible; the white firm and clear. There must be no visible development of the germ. The average weight of the eggs must be 24 ounces per dozen, with no eggs in a given dozen falling below an average weight of 22 ounces per dozen.

U. S. Extra. The air sac must be not more than one fourth of an inch deep, well localized and regular. The shell must be clean and sound. The yolk may be visible and the white clear and firm. There must be no visible development of the germ. The weight requirements are the same as for the U. S. Special.

U. S. Standard. The shell must be clean and sound. The air sac must be not more than three eighths of an inch in depth and may be slightly tremulous. The yolk may be visible and mobile. The white reasonably firm and the germ may be slightly visible. The size requirements are the same as for U. S. Special.

U. S. Trade. The shells must be clean and sound. The air sac may be more than three eighths of an inch deep and freely mobile. The yolk may be plainly visible and freely mobile and the white may be weak. The germ may be clearly visible, but no blood seen. Weight requirement same as other grades.

U. S. Checks. The shells may be dirty and checked and even cracked. The air sac may be more than three eighths of an inch in depth and freely mobile. The yolk may be plainly visible, dark, and freely mobile. The white may be watery. The germ may be clearly visible, but no blood must show. There is no minimum weight requirement.

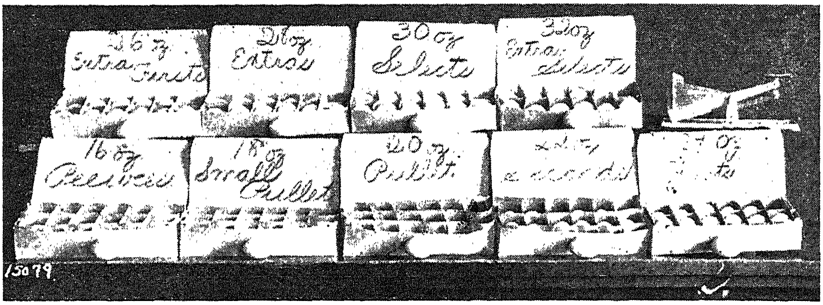


Figure 123. Eggs classified on the basis of weight per dozen.

Factors Affecting Size. The size of the egg is influenced very little, if any, by the feed. Heredity and the age of the laying hen are the main factors that affect the size of the egg. When pullets start laying, the eggs are usually small; but, if the pullet has the right inheritance for egg size, the eggs soon become normal. The only sure means of producing large eggs is to select breeding stock that has the inheritance for the production of large-sized eggs.

Factors Affecting Color. The most important factor affecting color is breed. Of the representative breeds, all the Mediterranean breeds and the Dorking of the English breeds produce white eggs. All the more common of the American, Asiatic, and English breeds, with the exception of the Dorking, produce brown eggs.

Within the breeds there is considerable variation among individual hens in the color of the eggs they lay. There is also some variation in the color of eggs produced by the same hen. As a rule, the color decreases as the period of daily laying progresses.

Flavor. As with milk, the flavor of the egg is markedly influenced by the feed. The normal feeds do not have any marked effect upon the flavor, but a number of substances that hens may pick up may produce decided off-flavors. Among these are onions, garlic, coal-tar products, turnips, fish fat, and a number of others. To avoid off-flavors in eggs, nothing but clean feeds free from any strongly-flavored ingredients should be fed.

Strength of the Shell. Thin-shelled eggs are obviously undesirable on account of the ease with which such eggs break. Shell thickness is influenced by feed and the individuality of the hens. The two important nutritional factors are Vitamin D and calcium. In the case of insufficient quantities of either of these, the egg shell becomes progressively thinner, until it finally disappears and laying stops. It is, therefore, important that plenty of oyster shells or limestone be present at all times, and, if the laying hens are not out in the direct rays of the sun, that Vitamin D be supplied in some form, such as cod-liver oil.

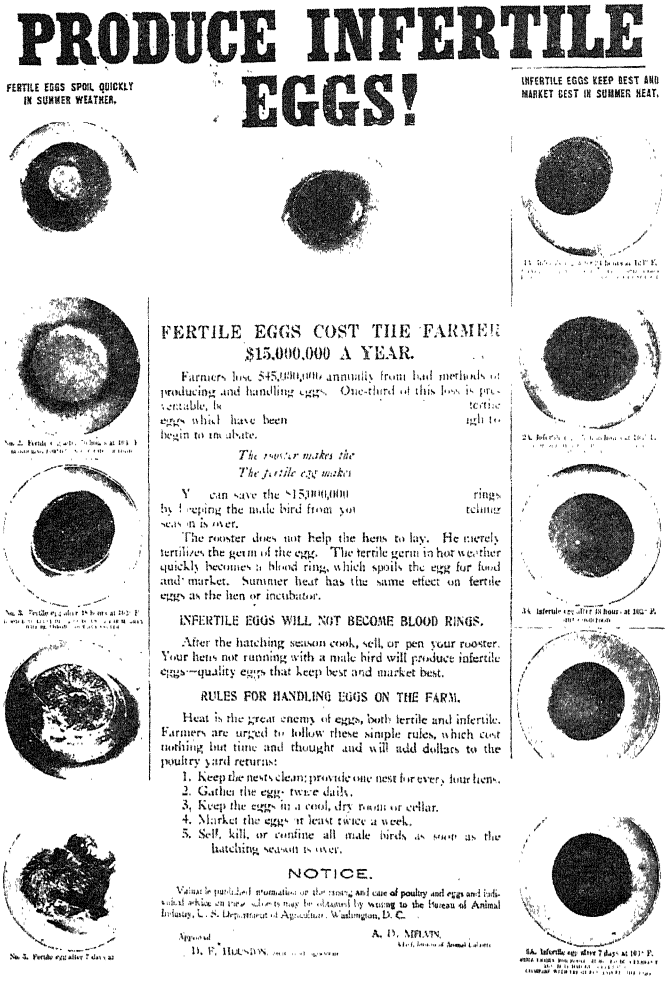
Sometimes individual hens will lay soft-shelled eggs, even when there is an abundance of both calcium and Vitamin D. This abnormality is usually due to a failure of the shell gland to function or to the egg's being expelled before the shell is properly put on.

Defects in Eggs When Laid. The egg, when laid, may present other abnormalities. Among the more common ones are double yolks, yolkless eggs, blood spots, or meat spots, body checks, and off-shaped eggs. The double yolks are produced when two yolks are released at the same time and pass down through the oviduct together. As a rule, double-yolked eggs are larger than the normal; otherwise they appear like the normal eggs.

Often very small eggs contain no yolk, but otherwise appear normal. They are caused by some foreign substance, such as a tiny blood clot or bit of tissue, which travels down the oviduct.

Blood spots or meat spots are two of the more serious defects of eggs. These are blood-like or, sometimes, as the name implies, meat-like spots in the yolk of the egg. Blood spots may also appear in the white. The blood spots in the yolk are caused by the rupturing of tiny blood vessels in the follicle or oviduct. The meat spots are caused by the breaking away of small bits of tissue in the reproductive tract and that become lodged in the yolk. The presence of either blood spots or meat spots lowers the grade of the egg.

Body checks is the term applied to the roughened egg, caused apparently by a break in the shell before it is completed. Attempts at repairing the break account for the abnormality. This defect does not in any way affect the quality of the contents of the egg, but does detract from its appearance. Factors affecting the shape of the egg are not too well known. It is believed that inheritance plays the major role in determining the shape. In marketing, uniformity in shape is important, although short



PRODUCE INFERTILE EGGS!

FERTILE EGGS SPOIL QUICKLY IN SUMMER WEATHER.

INFERTILE EGGS KEEP BEST AND MARKET BEST IN SUMMER HEAT.

FERTILE EGGS COST THE FARMER $15,000,000 A YEAR.

Farmers lose $45,000,000 annually from bad methods of producing and handling eggs. One-third of this loss is preventable, be … fertile eggs which have been … igh to begin to incubate.

The rooster makes the
The fertile egg makes

Y… can save the $15,000,000 … rings by keeping the male bird from you … tching season is over.

The rooster does not help the hens to lay. He merely fertilizes the germ of the egg. The fertile germ in hot weather quickly becomes a blood ring, which spoils the egg for food and market. Summer heat has the same effect on fertile eggs as the hen or incubator.

INFERTILE EGGS WILL NOT BECOME BLOOD RINGS.

After the hatching season cook, sell, or pen your rooster. Your hens not running with a male bird will produce infertile eggs—quality eggs that keep best and market best.

RULES FOR HANDLING EGGS ON THE FARM.

Heat is the great enemy of eggs, both fertile and infertile. Farmers are urged to follow these simple rules, which cost nothing but time and thought and will add dollars to the poultry yard returns:

1. Keep the nests clean; provide one nest for every four hens.
2. Gather the eggs twice daily.
3. Keep the eggs in a cool, dry room or cellar.
4. Market the eggs at least twice a week.
5. Sell, kill, or confine all male birds as soon as the hatching season is over.

NOTICE.

Valuable published information on the raising and care of poultry and eggs and individual advice on these subjects may be obtained by writing to the Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C.

A. D. MELVIN,
Chief, Bureau of Animal Industry.

Approved:
D. F. HOUSTON, Secretary of Agriculture.

Figure 124. The United States Department of Agriculture urges flock owners to keep roosters out of their flocks while market eggs are being produced.

round eggs do not make a good appearance and long narrow eggs are more easily broken in handling.

Keeping Quality. There are several factors that influence the keeping quality of eggs besides storage conditions. The most important of these factors is that of fertility, followed by cleanliness, and, in some cases, feed is a factor.

One of the more important factors in the improvement of egg quality is to produce infertile eggs except for hatching. The difference between fertile and infertile eggs kept under the same conditions is presented in Figure 124. A fertile egg kept at a temperature of 100° F. will have the germ sufficiently developed in 48 hours to cause such an egg to be rejected for food. It is, therefore, important that, as soon as the hatching season is over, all males be removed from the laying flock and that they are not returned until a few days before the next hatching season begins.

Cleanliness. There are two reasons for producing clean eggs. One is that clean eggs have a greater appeal and the other is that dirty eggs spoil more rapidly. The normal egg, when laid, contains no bacteria. If kept clean, there is little chance for bacteria to enter; but, if soiled, the protective coat on the shell is dissolved and bacteria gain entrance. Washing soiled eggs improves the appearance, but does not help from the contamination standpoint. As a matter of fact, washing removes the protective coat and facilitates the entrance of bacteria into the egg. For this reason, eggs should not be washed unless they are very dirty. Washed eggs should be marketed as soon as possible after being produced.

Eggs become soiled from dirty surroundings. The floors and nests should be kept clean and well supplied with clean dry litter of which the cereal straws are the most commonly used. The runways and yards should also be kept clean and dry, else the feet become soiled and dirt is transferred to eggs in the nest.

When eggs are only slightly soiled, they should not be washed, but the dirt should be removed with fine sandpaper or steel wool. When most of the egg is soiled, it becomes necessary to wash it. Washed eggs lose their luster, besides being more liable to be infected with bacteria, and, therefore, should be kept separate from the clean unwashed eggs.

Feed Effects upon Keeping Quality. While different feeds may affect the keeping quality of eggs in different ways, only in case of the effects of cottonseed meal has this problem been carefully studied. Eggs produced when cottonseed meal is fed appear normal when laid; but, after being in storage for about four weeks, discolored spots appear in the yolks. Nothing but discontinuance of cottonseed meal will overcome this difficulty.

Gathering and Storing Eggs. The rate of deterioration of eggs is in direct proportion to the temperature at which they are kept. During the warm weather it is important that the eggs be gathered as soon after they are laid as possible and that they be placed in a clean airy place at 65 degrees F. or lower. During the summer, eggs should be gathered at least three times daily—twice in the morning and once during the afternoon. During the winter, gathering eggs twice daily is sufficient.

In grading eggs the size of the air sac is an important factor. The air sac becomes enlarged, due to loss of moisture from the egg. Two factors are responsible for rapid loss of moisture from the egg. They are high temperatures and dry atmosphere. It should also be noted that washed eggs lose moisture much more rapidly than unwashed ones, because washing removes the protective coat that impedes the loss of moisture.

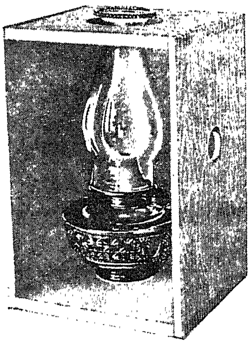


Figure 125. A homemade candler.

Candling Eggs. With the exception of size, color, cleanliness, and uniformity, all the other factors that compose egg grade are determined by candling. The principle of candling is merely to pass a strong light through an egg, when the important inside structures may be determined. A homemade candler is illustrated in Figure 125. Note the hole in the side into which the eggs are placed. An electric light bulb may be used in place of the kerosene lamp. A hole in a cardboard held up against a window pane will do very well as a candling unit. In candling, the room is darkened, so that the only source of light is through the egg.

After gaining some experience, one may ascertain the following defects in an egg:

1. Large air sac.
2. Condition of the white. When the white is firm the yolk shows up but dimly.
3. Blood spot or meat spot.
4. Double yolk.
5. Yolk stuck on one side of the shell.
6. Movable air sac.
7. Developing germ.
8. Rots.

Home Preservation of Eggs. It is often desirable to preserve eggs for future use on the farm. In the case of low prices during the high-production periods, it may be good economy to preserve the eggs for use when the prices are higher. The most successful method of preserving eggs on the farm is by the use of soluble water glass, also known as soluble sodium silicate.

Following is the procedure for using this material:

1. Select 15 dozen clean, fresh eggs that do not have cracked or checked shells.

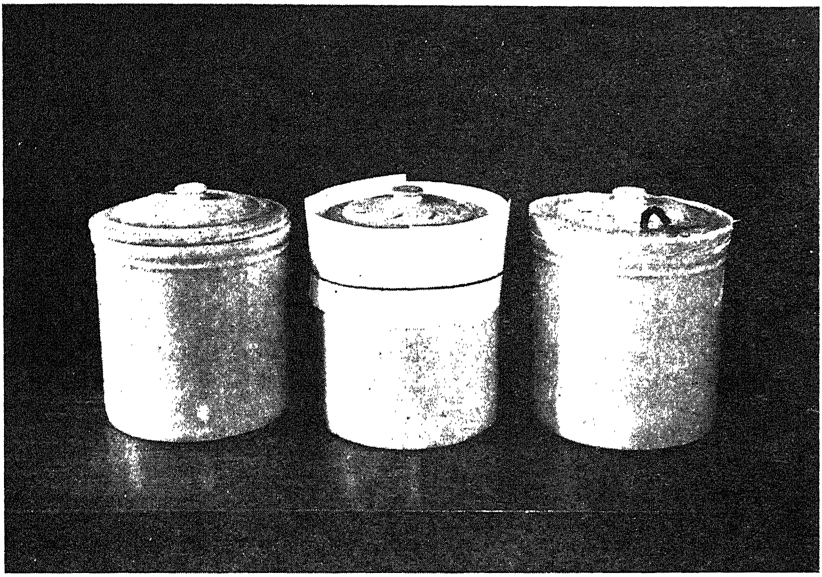


Figure 126. Fresh eggs may be stored satisfactorily with water glass in earthenware crocks.

2. Clean and scald a five-gallon earthen jar and let it dry.
3. Bring 11 quarts of water to a rolling boil and allow it to cool.
4. When cool, thoroughly mix 9 quarts of it with 1 quart of sodium silicate.
5. Put this solution in the earthen jar, and, when thoroughly cool, put in the eggs and allow at least 2 inches of the solution above them.
6. Place the crock in a cool, dry place, and cover with three sheets of wax paper tied about with string.

Eggs preserved in water-glass solution may be kept indefinitely without spoiling, provided perfectly fresh eggs are used. During the storage some changes take place, so that the stored preserved eggs differ from strictly fresh eggs. The whites gradually lose some of the firmness and some difficulty will be experienced when poaching is attempted. The wholesomeness of the preserved eggs, however, is unimpaired.

Suggestive Questions

1. Compare the relative merits of the various grains for poultry feeding.
2. Should animal proteins be included in the ration of poultry? Why?
3. What are the different vitamins that must be furnished poultry and how may they be supplied?
4. Why must both lime and grit be supplied?
5. State the relative merits of the two methods of sexing chicks.
6. What are the main factors in broiler production?
7. Under what conditions may capons be produced successfully?
8. What special precautions must be taken in caponizing birds?
9. Distinguish between the defects of eggs that are not under the control of the flock manager and those that are.
10. Name the most important factors that influence the quality of eggs.
11. Why are washed eggs objectionable?
12. What may candling tell about an egg?
13. Describe a method for preservation of eggs in the home.
14. Outline the necessary steps in producing eggs of high quality.

Suggestive Activities

1. Collect samples of the various feeds available in your community and mix a mash that will be satisfactory for the grains that are used.
2. Determine the sex of day-old chicks.
3. On a dead cockerel perform the caponizing operation, observing carefully all the details involved.
4. Have a demonstration of caponizing live birds.
5. Construct suitable apparatus for candling, and proceed to grade a variety of eggs according to the Federal and State Grades.
6. Collect eggs with varying defects.
7. Prepare a suitable solution of sodium silicate and preserve some eggs.

CHAPTER XXV

TURKEY PRODUCTION

No farm enterprise has seen greater changes during the past few years than turkey production. The number of turkeys produced has greatly increased and the methods of raising them have practically been revolutionized. While, for the most part, turkeys were formerly raised upon the range, the modern method calls for close confinement. This change has been made necessary primarily to control disease, of which blackhead is the most devastating. Simultaneously with the change in the method of raising turkeys there has been a shift from nearly all small producers to greater quantity production by large commercial turkey growers.

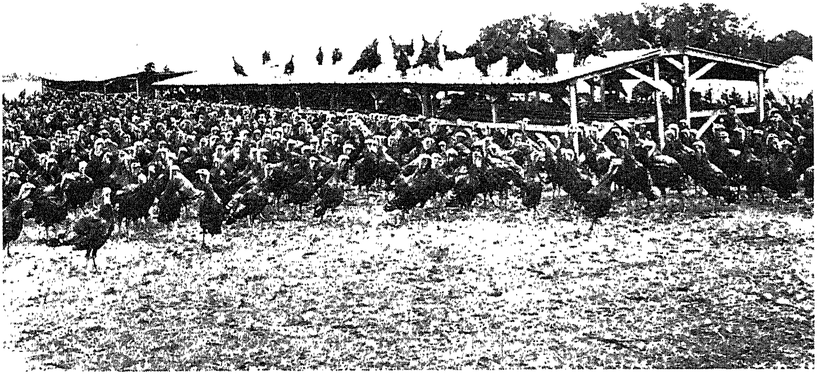


Figure 127. A large flock of turkeys on the range.

Notwithstanding the trend toward larger turkey farms, there is a definite place for the production of small flocks upon many farms. It is the purpose here to deal with the fundamental problems incident to the raising of turkeys on the average farm. Turkey problems naturally begin with the hatching of the eggs and are followed in order by the problems incident to the care of the newly hatched poults, brooding, care of the poults after brooding, care of the growing turkeys, fattening turkeys for the market, and care of the breeding flock. In addition to these topics, the diseases and pests that afflict turkeys will be considered.

PLAN FOR REARING TURKEYS IN CONFINEMENT

As will be shown later, the big problem in raising turkeys is prevention of disease. Every possible precaution must be taken to prevent contact with any possible source of infection. It has been definitely proven that contact with chickens either directly or with the ground upon which they have been is a source of danger. When chickens are or have been raised on the farm, care must be taken that the turkeys are always kept away from them or any ground upon which they may have been.

The brooder house, yards, roosts, and other equipment must be kept away from the premises where chickens are kept. Another important point is that the turkeys themselves contaminate their own premises, and, in order to avoid such contamination, they must be moved at frequent intervals to new and clean grounds.

A third important general principle in successful turkey raising under the confinement plan is to have all equipment and utensils with which the turkeys come in contact, either directly or indirectly, thoroughly sterilized.

Hatching Turkey Eggs. Turkey eggs require 28 days for hatching. They may be hatched under turkey or chicken hens or in incubators. Incubator hatching is preferred by most people that have given this method a trial. Before the eggs are placed in the incubator it should be thoroughly cleaned and disinfected in order to destroy any infectious organisms or parasites that may be there. It is also important that the eggs be from disease-free hens.

The care of the incubator during the hatching of turkey eggs is not essentially different from that required in hatching chicken eggs. The temperature should be 101.5 degrees F. which toward the end of the hatching period rises to 103 to 104 degrees. The incubator should be kept moist with a plate of soaking wet sand. The eggs should be turned twice daily.

When a chicken hen is used for hatching, she may be set upon 9 to 11 eggs. A turkey hen can properly cover 15 to 18 eggs. When eggs are hatched in the natural way, either the poults may be given to the hens to brood, or they may be removed to an artificial brooder. If the hens are to brood the poults, they and their brood should be placed in a small movable coop removed some distance from the premises and preferably to a field of alfalfa.

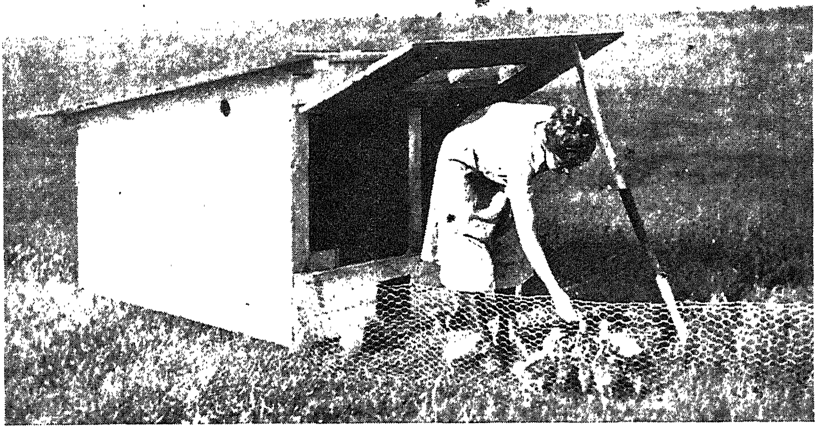


Figure 128. A small portable coop that may be used when turkeys are hatched either by turkey hens or chickens.

When the eggs are hatched by the incubator, the newly-hatched poults should be kept in the egg tray of the incubator until thoroughly dry and then transferred to the incubator nursery until they are 24 to 36 hours old, when they should be removed to the brooder.

Brooding. Although the eggs hatched under either chicken or turkey hens, may be brooded by them, it is preferable that the hens should not be used in brooding, as they are likely to introduce disease. Artificial brooding must, of course, be used for the incubator-hatched poults.

A brooder house recommended by Billings, of Minnesota, is 12 by 14 feet and will accommodate 200 to 250 poults. The floor plan of the brooder is given in Figure 129. It will be noted that the corners are cut off by means of heavy roofing to prevent crowding. Heat is supplied by a coal stove which should maintain the temperature at about 98 degrees F. at first. As the birds grow older the temperature is lowered until no more heat is needed. The front elevation and cross section of the brooder are given in Figures 130 and 131. A unique feature of the brooder plan is presented in Figure 132. It makes provision for four yards, one from each side of the brooder house in which the poults can be placed when old enough. The first week they are permitted in yard one; the second week this yard is closed and they are permitted in yard two, and so on until all four yards have been used.

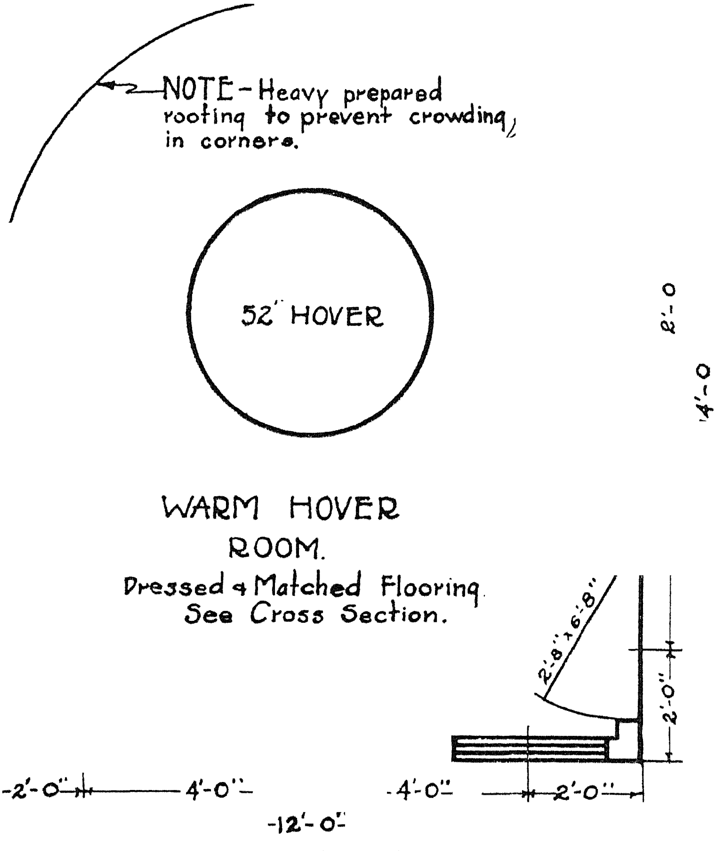

NOTE - Heavy prepared roofing to prevent crowding in corners.
52" HOVER
8'-0
4'-0
WARM HOVER ROOM.
Dressed & Matched Flooring. See Cross Section.
2'-8"x6'-8"
2'-0"
-2'-0"
4'-0"
-4'-0"
2'-0"
-12'-0"
PLAN

Figure 129. Floor plan of a portable brooder house with hover and a roofing-paper fence to keep the young poults from getting into the corners where they may become chilled.

The yards are 8 feet wide and 12 to 16 feet long. They are fenced with poultry fencing 4 or 5 feet high. It is obvious that, in order to make use of this system, the brooder house must have a door on each side to permit the poults to go in and out of the house. When the poults are from 6 weeks to 8 weeks of age, they may be moved to the rearing ground, provided the weather is suitable.

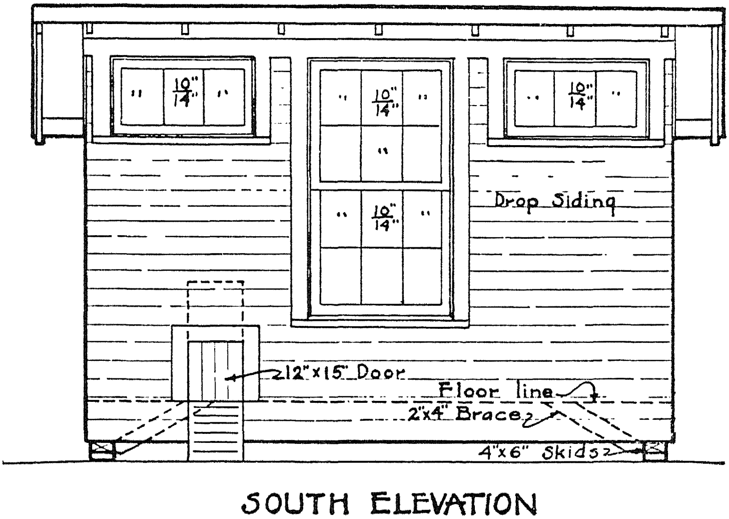


Figure 130. Front elevation of the brooder house pictured in Figure 129.

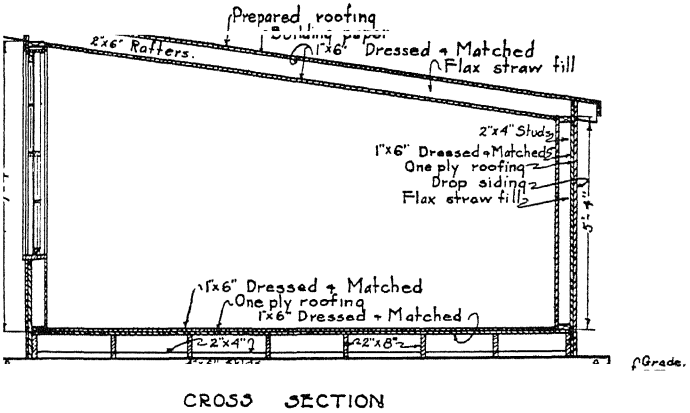


Figure 131. End elevation of the brooder house illustrated in Figure 129.

Sand is the best litter for the brooder house, although many successful growers use straw, shavings, sawdust, peat, or other materials. The important point is that whatever is used must be clean and free from mold. When sand is used, it should be coarse, be raked each day, and be completely changed weekly.

The Rearing Ground. The important points about the rearing ground are that (1) it must be located away from the chickens, (2) it must be large enough, (3) it must have green material, (4) it must have shelter, (5) it must have the proper feeding equipment, and (6) it must be changed frequently.

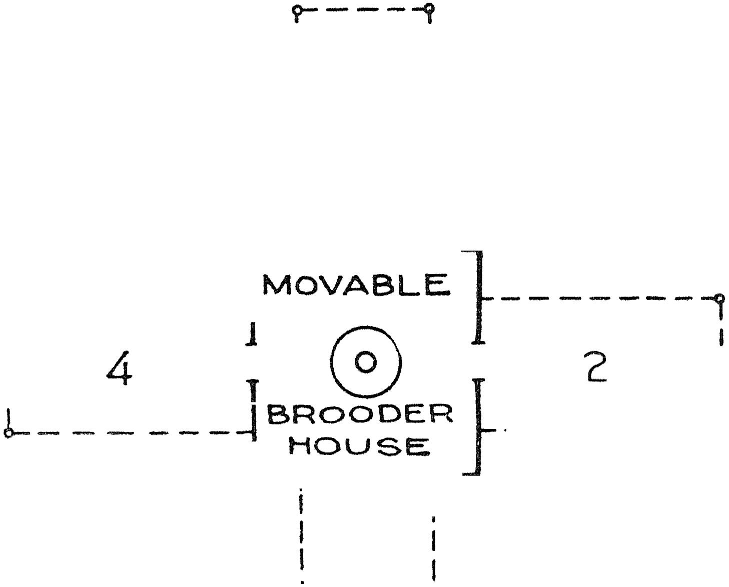


Figure 132. Illustrating how four small yards may be located around the brooder house and used in rotation by the young poults.

For the sake of safety the turkey grounds must be located not less than 200 yards from the farm buildings, else there will be danger of contamination from the chickens.

Turkeys do not need a large space, but the grounds should be large enough to prevent crowding and to supply green material. For the first month after leaving the brooder, 200 to 300 birds need no more than an eighth of an acre. After the birds become larger, more ground is needed. Large birds in the late summer will need an acre for 400 to 500 individuals.

The rearing grounds should provide plenty of green pasture. For this purpose alfalfa is the best, with clover ranking second. Any other green material will do. In order that the pasture will be eaten off evenly, it is usually necessary to move the feeding places often, particularly when the birds are young, as the turkeys will not graze far from the eating place.

The rearing grounds should be provided with a shelter. It need not be elaborate or expensive. Many provide merely a roof under which the roosts are set. Others provide a shelter with a roof and three sides boarded up with a single layer of boards. It is highly desirable that, whatever type of shelter may be provided, it be mounted upon skids, so that it may be easily moved.

One of the more important points in the management of the flock is to move it frequently. The ground should be changed at least once a month and preferably more often. Whenever a piece of ground becomes soiled, the flock should be moved to a fresh pasture regardless of how long the birds may have been upon it.

The grounds should be enclosed with a 5 or 6-foot-high poultry fence. Sometimes some of the birds develop the habit of flying over the fence. This habit may be stopped by clipping the flight feathers of one wing.

Three pieces of feeding equipment are needed—two hoppers and a trough for water or milk. One of the hoppers is used for the mash and the other is used for the scratch feed. The hoppers should be sufficiently large that the birds will not crowd and also that enough feed can be put in to last for at least a day. A general idea of the type of hopper that will be satisfactory may be gained from Figure 133.

FEEDING TURKEYS

There are as many satisfactory mixtures of feeds for turkeys as there are for poultry. In general, the feeding problem in turkey-raising can be divided into two parts. These are: starting the poults and growing and fattening of the turkeys.

Immediately after the poults are removed to the brooder they should be fed. Either a starting turkey mixture may be purchased or mixed at home. One starting mash recommended by the Minnesota Station consists of equal parts of:

Finely ground corn meal.
Wheat bran.
Oat flour.
Wheat middlings.
Beef scrap.
To this is added 5 per cent of bone meal and 1 per cent of salt.

For early-hatched poults and before they are exposed to the direct sunshine, there should be added cod-liver oil at the rate of 1 quart per 100 pounds of mix. After the poults get out on the green pasture, the cod-liver oil may be omitted, as they will get sufficient Vitamin A from the green material and Vitamin D from exposure to the sun's rays.

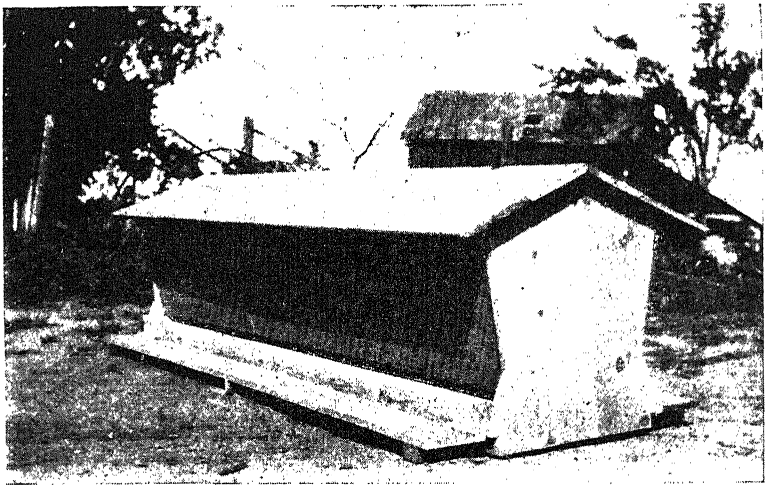


Figure 133. A feed hopper of which at least two are needed. One contains the mash and the other the grains. Note the overhanging eaves and the platform upon which the birds stand during feeding.

Finely chopped greens, such as lettuce leaves, are desirable for the young birds and should be furnished, if possible. Additional bone meal and oyster shells should also be available in a small hopper where the birds may take the minerals whenever they desire.

While many people believe that the quantity of feed should be limited to young birds, the more successful raisers let the young poults eat all the mash they want and any time they will. The mash should, therefore, be placed in hoppers that are available to the birds at all times. Liquid should also be constantly available. If skimmilk is at hand, it may be used instead of water. For the very young turkeys it should be sweet and clean.

As the birds get a little older, sour skimmilk or buttermilk is equal to the sweet, provided it is not putrifying.

After the poults are a week old, it is well to supply them with scratch feed. A mixture of equal parts of finely-cracked corn and wheat makes an excellent scratch feed.

The length of time that the poults should be kept upon the starter mash is not definite. Some change to the growing ration after the poults are three weeks old, while others do not make the change until the birds are taken from the brooder houses to the rearing ground. Although the starter mash is more expensive than the growing mash, the young birds eat such small quantities that the small difference in cost is not a very serious matter.

Growing and Fattening Rations. When the birds are turned out on the rearing grounds, if not sooner, they should be put on the growing ration and continued upon this ration until they are marketed. Again, there are many different rations that will prove satisfactory for growing and fattening turkeys. The principle in growing and fattening turkeys is the same as for growing and fattening swine; that is, they should be kept growing and in condition at all times. There is, therefore, no special fattening ration, if the proper growing ration is furnished.

Two such rations recommended by the University of Minnesota and that will serve as guides in making up growing and fattening rations for turkeys follow:

Ration I

Ground corn, 100 parts.
Ground oats, preferably hulled, 100 parts.
Wheat bran, 100 parts.
Wheat middlings, 100 parts.
Meat scraps, 100 parts.
Bone meal, 25 parts.
Salt, 5 parts.

Ration II

Ground corn, 20 parts.
Ground wheat, 40 parts.
Ground oats, 20 parts.
Meat scrap, 20 parts.
Bone meal, 5 parts.
Salt, 1 part.

In addition to either one of the above rations there should be furnished a scratch feed, liquid, grit, oyster shells, and additional bone meal. The scratch feed preferred by most people consists of equal parts of ground corn and wheat. Skimmilk or buttermilk furnishes the best liquid. Either may be fed sweet or sour; and, if available in large enough quantities, no other fluid need be furnished. If the supply of milk is inadequate, water must be furnished in addition. As milk is one of the best sources of protein for the growing turkey, it is one of the valuable ingredients of the ration.

Grit, oyster shells, and bone meal should be supplied in hoppers, so that the birds may help themselves to whatever they may want of these substances. If the ration is otherwise adequate, the young turkeys will consume just what they need and no more.

Green Feeds. Green feeds supply two essentials to the ration. These are Vitamin A and succulence. Vitamin A is deficient in the grains and the mash and must be supplied in some other form. For the young poults, before they are turned out on the pasture, it is necessary to add cod-liver oil to the ration to supply this vitamin. When the turkeys have access to good green pasture, sufficient quantities of this vitamin are secured from this source. Green alfalfa or clover surpasses other green feeds for turkeys. Successful turkey growers arrange for an abundance of green material in either alfalfa or clover, if possible. If neither of these crops is available, rape may be substituted for them quite satisfactorily. Soybeans or any of the growing cereal grains may also be used. If cereal grains or other annuals are planted for a source of pasture, the seed should be sown, so that a good stand is ready just before the birds are moved.

CARE OF THE BREEDING FLOCK

The breeding flock is maintained primarily for the production of eggs. The care and management of the breeding flock should, therefore, be such that will produce the largest number of eggs. While it is easy to care for mature turkeys, there are certain features about their selection, housing, feeding, and general management that need to be considered.

Selection. With the exception of unusually good layers, turkey hens should not be kept for more than one year. This practice necessitates the selection of the entire breeding flock each year from the year's crop. The birds to be used for breeding should be selected for their size, vigor, and form. Selection of the smaller, less vigorous birds for breeding purposes, as is sometimes done because such birds are not marketable at the time the better ones are, is to be condemned, as such birds are likely to transmit their undesirable characteristics to the offspring.

Housing. Mature turkeys need but very little protection in the way of housing. A structure consisting of a roof with three sides boarded up, much the same as described for the market flock, is adequate in the coldest of climates.

As with the young turkeys, the breeding flock should be protected against disease in every possible way, for diseased turkey hens become poor layers. The breeding flock should be kept in yards located about 300 feet from the farm buildings to give the necessary protection against contamination from the chickens. The yard may be fenced in the same manner as the rearing grounds. About an eighth to a quarter of an acre should be provided for each 12 or 15 birds.

Feeding. Feeding of the breeding flock is divided into two periods—that following the selection and including the first part of the winter, and the other the period during which they are being prepared for the laying season. Immediately after the breeding flock has been segregated from the birds that are to be marketed, they should be put on a maintenance ration until they are to be fitted for the egg-laying season. The maintenance ration may be the growing ration which is fed night and morning rather than kept before the birds at all times.

From the middle of January and on to the first of February the flock should be put on full feed. The earlier that full feeding is started, the sooner the hens will start laying. The ration used during this period may be the one used during the growing season or any good laying mash may be used. It is important that plenty of ground oyster shells and bone meal be available at this time.

Other Management Factors. As soon as the hens show a desire to lay, boxes or barrels should be placed in the yard for nests. Because turkeys like to have their nests well hidden, these may be partially covered with straw or hay.

The eggs should be collected preferably twice daily and stored in a room at 45 degrees F. They should be turned daily and, for the best results, should be kept not over two weeks before incubating begins.

One tom should be kept for each 12 to 15 hens. If two or more toms are kept, they may run with the flock unless they fight, in which case they should be alternated. Sometimes the toms injure the hens with their spurs. If so, their spurs should be trimmed and bound with adhesive tape.

AILMENTS OF TURKEYS

Turkeys are subject to a number of diseases, the more important of which are: blackhead, roup, and tuberculosis. Of the most troublesome parasites, lice, mites, ticks, roundworms, and tapeworms must be listed.

Blackhead. Blackhead is without question the most devastating disease that afflicts turkeys. It has been the reason why many have discontinued turkey-raising. It also has compelled the confinement plan of raising turkeys, with its rotation of pasture and the extreme sanitary measures that must be taken.

Blackhead is a highly infectious disease that affects turkeys of any age, although young birds and those nearing the finishing period are the most susceptible. The organism causing the disease enters through the digestive tract, being taken in with the food. The first symptoms are a loss of appetite and general listlessness. In most cases there is diarrhea, the feces being yellow or a greenish yellow. These may be the symptoms of other diseases and are, therefore, not positive for blackhead. Blackhead may be positively diagnosed by a post-mortem examination. If the bird is infected with blackhead, the caecum and the liver are affected. The caecum is enlarged, inflamed, and usually filled with a yellow cheesy material. The liver of infected birds has round spots with greenish yellow borders. The spots are elevated above the surface of the liver and resemble small ulcers.

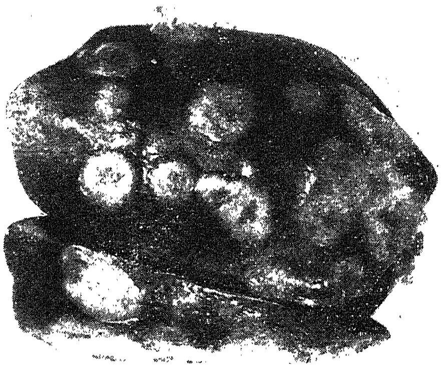


Figure 134. Appearance of the liver of a turkey infected with blackhead. Note the elevated ulcer-like spots.

Method of Infection. For serious infection of turkeys with blackhead both the blackhead organism and the eggs of the small intestinal worm of the chicken must be present. When both the blackhead organism and the eggs of this worm are in the soil, they are taken into the digestive tract of the turkey, hatch into small worms in the intestine, and injure the lining, so as to facilitate the entrance of the blackhead organism into the intestinal wall and into the system in general. The disease localizes in the liver and the caecum, causing the disturbances previously described.

The small intestinal worm, or caecal worm, commonly infests chickens, but does no particular damage. The chickens eliminate eggs of this worm with the feces and pollute the soil. This danger is the reason that it is important to keep turkeys away from soil upon which chickens have been kept.

Treatment. There is no cure for blackhead, once a bird becomes infected. The only way to prevent losses from this disease is to keep the turkeys away from ground upon which there have been chickens, and to change the ground often to avoid infection from turkeys that may have become infected.

Roup. Roup in turkeys is similar to that in chickens. It is described in *Agriculture II*, page 439. As a turkey has a greater value than a chicken, individual treatment for turkeys is more advisable than for chickens. Infected birds should be isolated from the healthy ones as soon as the symptoms appear. In severe infections of poults treatment is of questionable value. When the infection is mild, the best treatment is to place a drop or two of a 10 per cent argyrol solution in each eye. This same treatment is also advised for mild infections in older birds. When the disease has advanced in older birds to the stage where abscesses are formed below the eyes or in the nostrils, such abscesses should be opened with a sharp penknife, the pus squeezed out, and the cavity cleansed with warm water preferably applied with a syringe. After washing, the abscess should be filled with a solution of 10 per cent argyrol.

Tuberculosis. Turkeys are not infected with tuberculosis as frequently as chickens, yet the disease is sometimes the cause of heavy losses. The most common source of the infection is from chickens. When turkeys are raised away from the farm buildings and all contacts with chickens are avoided, there is very little danger that tuberculosis will develop in the flock, provided the birds were healthy at the start.

The symptoms of the disease are the same as in chickens, described in *Agriculture II*, page 442. As with chickens, there is no effective treatment for tuberculosis in turkeys. When infection gains entrance into a flock, the tuberculin test should be applied and all reacting birds destroyed. If the infection involves a large percentage of the flock, it is best to dispose of the entire flock, disinfect the premises, and start over with disease-free stock.

Lice. Turkeys are subject to the same kinds of lice as chickens, of which the head louse and the body louse are the most serious. As with most other turkey afflictions, the chicken is usually the source of the lice on turkeys. When the hen is used for hatching turkey eggs, she should be thoroughly deloused before being set. Directions for delousing are given in *Agriculture II*, page 431. If the poults should become infested with lice, they should be treated with sodium fluoride in the same manner as directed for chickens.

Mites. The mites attacking turkeys are the same as those attacking chickens and the treatments are also the same. To prevent mites from infesting turkeys, it is important that the house and all equipment with which the young poults come in contact be free from the pests. Mites may be eliminated by painting the equipment with a mixture of four parts of crank-case oil and one part of kerosene.

Ticks. Turkeys are subject to the attack of the bird tick, which differs from the fowl tick. This pest resembles the wood tick and attaches itself somewhat like a wood tick. The head and neck are favorite parts for attack. When birds are attacked by large numbers of these ticks, death may be the result.

Infestation of turkeys from this pest is most likely to occur where wild birds, such as pheasants and partridges, have previously roamed over the grounds. The only treatment is to pick the ticks off by hand and destroy them.

Roundworms. When turkeys become infested with roundworms, it is usually a sure sign that the rules relating to the complete isolation of turkeys from chickens have not been carefully observed, for the turkey picks up the roundworms from the chicken.

The symptoms and treatment of roundworms in turkeys are the same as described for the chicken in *Agriculture II*, page 433. Turkeys sick from the infestation of roundworms may appear like those infected with blackhead. The only sure way to differentiate between the two is to examine dead birds by opening them. The roundworms may be detected, if present, by slitting open the intestine. They will appear as white sharp-pointed worms in the intestinal content. The larger ones may be up to four inches in length.

Tapeworms. Like chickens, turkeys are subject to tapeworms that often cause heavy losses. The symptoms and treatment are the same as described for chickens in *Agriculture II*. The doses of kamala are larger for turkeys than for chickens and should vary with the size of the birds. An adult turkey should have a gram of kamala. For birds weighing between 3 and 6 pounds the dose is one half a gram and a quarter of a gram for birds under three pounds.

Suggestive Questions

1. Describe the confinement system of raising turkeys.
2. Compare the different methods of hatching turkey eggs.
3. Why is it important that turkeys be kept away from chickens?
4. Why should turkeys frequently be moved to fresh clean grounds?
5. What are the important considerations in starting young poults? In growing poults?
6. Explain the essential differences of starting rations and growing rations?
7. What are the important considerations in preventing disease?
8. How should the breeding flock be cared for?
9. How may early laying of turkey hens be induced?

Suggestive Activities

1. Prepare plans and calculate the cost of the necessary brooder, yards, housing, and equipment for 200 turkeys.
2. Procure the necessary ingredients and prepare a starting ration.
3. Obtain the necessary feeds and prepare the growing mash.
4. Perform a post-mortem examination on some dead turkeys to ascertain the cause of death.
5. Obtain some organs of turkeys affected with blackhead and tuberculosis and preserve them in a 10 per cent formalin solution. A 10 per cent formalin solution is prepared by mixing one part of a 40 per cent formalin with 10 parts of water.

SOURCES OF ILLUSTRATIONS

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American Crystal Sugar Company, Chaska, Minnesota: Figure 11.

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